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INSTRUCTIONS
FOR
VOLUNTARY OBSERVERS
OF THE
SIGNAL SERVICE,
UNITED STATES ARMY.

1882

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INSTRUCTIONS

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OF THE

SIGNAL SERVICE,

UNITED STATES ARMY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1882.

INSTRUCTIONS No. 23.

WAR DEPARTMENT,
OFFICE OF THE CHIEF SIGNAL OFFICER,
Washington, February 8, 1882.

The following "Instructions for Voluntary Observers of the Signal Service, United States Army" have been prepared and are published to aid in securing the greatest uniformity in the observations made by voluntary observers, to whose labors the Chief Signal Officer desires to publicly acknowledge his indebtedness and thanks. Any defects observed and reported will be amended in revised editions of these "Instructions."

In this compilation the Chief Signal Officer desires to acknowledge his indebtedness to Mr. Robert H. Scott, Secretary of the Meteorological Council, London, England; the Smithsonian Institution, Washington, D. C.; Professor A. P. Deschanel, Inspector of the Academy at Paris, France; J. D. Evarts, M. A., D. C. L., F. R. S. E., Professor of Natural Philosophy in the Queen's College, Belfast, Ireland; Messrs. Negretti and Zambra, Instrument Makers, London, England, and others, for valuable extracts from their publications.

W. B. HAZEN,
Brig. & Bvt. Maj. Gen'l,
Chief Signal Officer, U. S. A.

INSTRUCTIONS

FOR

VOLUNTARY OBSERVERS OF THE SIGNAL SERVICE.

Observations are taken at the voluntary stations at the respective hours of 7 a. m., 2 p. m., and 9 p. m., *local* time, when practicable; but, when time cannot be given for these observations, a good record may be obtained by making two observations daily, selecting hours of the same name, *eg.*, 8 a. m. and 8 p. m., or 9 a. m. and 9 p. m.

All instruments should be of known reliability, and should therefore be of standard make, and their accuracy determined by comparison with standards before being used.

Accurate instruments will be procured for observers at actual cost price; they will be compared with standards at this office, and correction cards furnished free of charge.

At the close of this volume will be found the necessary tables, prepared in the most convenient form for observers, for use in reducing meteorological observations.

In the study of meteorology, instruments are required for determining—

1st. The temperature of the air.
2d. The absorption and radiation of the sun's heat by the earth's surface.
3d. The humidity of the air.
4th. The pressure of the atmosphere at any time or place.
5th. The amount and frequency of rain.
6th. The direction and velocity or force of the wind.
7th. The electrical condition of the atmosphere.

TEMPERATURE OF THE AIR.

Thermometry (heat and cold).—The words *heat* and *cold* express sensations so well known as to need no explanation, but these sensations are modified by subjective causes, and do not furnish an invariable criterion of objective reality; in fact, we may often see one person suffer from heat, while another complains of cold; even for the same person the sensations of heat and cold are comparative. A temperature of 50° Fahr. suddenly occurring amid the heat of summer, produces a very decided sensation of cold, whereas the same temperature in winter has exactly the opposite effect.

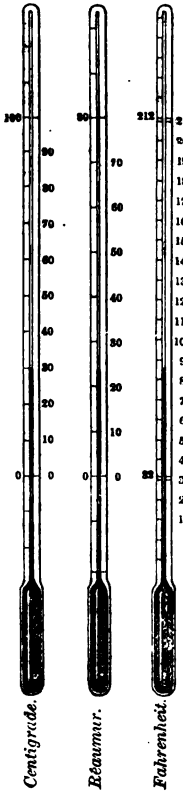
An old experiment upon this subject is simple and instructive. Plunge one hand into water at 32° Fahr., and the other into water at about 100°; after having left them some time in this position, if they are immersed simultaneously in water at 70° they will experience very different sensations. The hand which was formerly in the cold water

now experiences a sensation of heat; that which was in the hot water experiences a sensation of cold, though both are in the same medium. This plainly shows that the sensations of heat and cold are modified by the condition of the observer, and consequently cannot serve as a sure guide in the study of calorific phenomena. Recourse must therefore be had to some more constant standard of reference, and such a standard is furnished by the thermometer.

Temperature.—If several bodies heated to different degrees are placed in presence of each other, an interchange of heat takes place between them by which they undergo modifications of opposite kinds, those that are hottest grow cooler and those that are coldest grow warmer, and after a longer or shorter time these inverse phenomena cease to take place, and the bodies come to a state of mutual equilibrium. They are then said to be at the same *temperature.* If a source of heat is then brought to act upon them, they grow warm, and their temperature is said to *rise;* if they are left to themselves in a colder medium they all grow cold, and their temperature is said to *fall.* ***Two bodies are said to have the same temperature if, when they are placed in contact, no heat passes from the one to the other.*** If, when two bodies are placed in contact, heat passes from one to the other, that which gives heat to the other is said to have the higher temperature. Heat always tends to pass from bodies of higher to those of lower temperature.

General idea of the thermometer.—Since the volume of a body is always changed by heat, it follows that when a body is subjected to variations of temperature it undergoes at the same time corresponding variations of volume. Suppose that the different volumes successively assumed by the body can easily be measured, then the temperature may be indicated by stating the volume, and the body will not only indicate its own temperature by this means, but it will also exhibit the temperature of the bodies by which it is surrounded, and which are in equilibrium with it as regards temperature; that is, which do not experience those inverse changes heretofore mentioned. Such is the most general idea of the thermometer, which may be defined ***as a body which, under the action of heat, exhibits changes of volume which can be ascertained and measured.***

FIG. 1.



Thermometric scales.—In the *Centigrade* scale the freezing-point of water is zero (0°), and the boiling-point 100°. In *Réaumur's* scale, which is still sometimes used abroad, the freezing-point is also marked zero (0°), but the boiling-point is marked 80°. Hence, five degrees on the former scale are equal to four on the latter, and the reduction of temperatures from one of the scales to the other can be effected by multiplying by $\frac{4}{5}$ or $\frac{5}{4}$. The relation between either of these scales and that of Fahrenheit is rather more complicated, inasmuch as Fahrenheit's zero is not at freezing-point but at 32 of his degrees below it. As regards intervals of temperature 180°, Fahrenheit, are equal to 100, Centigrade, or to 80, Réaumur, and hence, in lower terms, 9° Fahrenheit are equal to 5 Centigrade, or 4 Réaumur. The conversion of temperatures themselves (as distinguished from intervals of temperature), will be best explained by a few examples.

EXAMPLE I.—To find what temperatures on the Centigrade and Réaumur scales are equivalent to the temperature 50° Fahrenheit: Subtracting 32, the difference, 18, is the number of Fahrenheit spaces (degrees) on the scale above freezing-point, and as this interval is equivalent to $18 \times \frac{5}{9}$, that is, 10° spaces on the Centigrade scale or to $18 \times \frac{4}{9}$, that is, 8° spaces on the Réaumur scale, the equivalent temperatures are respectively 10° Centigrade and 8° Réaumur.

EXAMPLE II.—To find the degree on Fahrenheit's scale, which is equivalent to the temperature 25° Centigrade. An interval of 25° spaces on the Centigrade is equal to $25 \times \frac{9}{5}$; that is, 45° spaces on the Fahrenheit scale, and the temperature in question is above freezing-point by this amount. The number denoting it on Fahrenheit's scale is, therefore, 32 + 45, that is, 77°.

The rules for the conversion of the three thermometric scales may be summed up in the following formulæ, in which F, C, and R denote equivalent temperature expressed in degrees of the three scales:

$$F = \tfrac{9}{5}\,C + 32 = \tfrac{9}{4}\,R + 32$$
$$C = \tfrac{5}{4}\,R = \tfrac{5}{9}\,(F - 32)$$
$$R = \tfrac{4}{5}\,C = \tfrac{4}{9}\,(F - 32)$$

It is usual in stating temperatures to indicate the scale referred to by the abbreviations Fahr., Cent., Réau., or, more briefly, by the initial letters F., C., R.

Alcohol thermometer.—In the construction of thermometers, other liquids may be introduced instead of mercury, and alcohol is very frequently employed for this purpose. But if an alcohol thermometer was constructed so as to agree with a mercurial thermometer at two fixed temperatures, and graduated by dividing the intervening space into equal parts, and continuing the equal graduations both ways, it would be found to give different readings from a mercurial thermometer, except at or very near the two fixed temperatures. This fact may be expressed by saying that alcohol does not expand equally for equal increments of temperature as indicated by a mercurial thermometer; or, more symmetrically, by saying that intervals of temperature which are equal as measured by the expansion of mercury, are not equal as measured by the expansion of alcohol. In practice, alcohol thermometers are graduated by comparison with mercurial thermometers, and the degrees of an alcohol thermometer have, consequently, unequal volumes in different parts of the scale. The degrees, in fact, increase in length as we ascend on the scale. Alcohol has the disadvantage of being slower in its action than mercury on account of its inferior conductivity, but it can be employed for lower temperatures than mercury, as the latter congeals at −39° Centigrade (−38° Fahrenheit), while the former has never congealed at any temperature yet attained.

Varieties of thermometers.—Several variations are made in thermometers intended for special purposes. The principal of these requiring notice are—

The mercurial exposed (dry bulb) for taking the temperature of air at the moment of observation.

The mercurial maximum thermometer, for registering the highest temperature attained in the day or other period.

The alcohol minimum thermometer, for registering the lowest temperature attained.

The mercurial solar radiation thermometer, for measuring the highest temperature of equilibrium in the sun's rays when the surrounding objects are constant.

Grass alcohol radiation thermometer, for measuring the cooling of air in contact with the earth's surface at night.

The exposed thermometer (dry bulb). This is the simplest form of the instrument, and requires no description beyond what has already been given. It is graduated with care, and, when the other thermometers have not been separately verified, serves as the standard with which these others are compared. But a matter which requires great consideration is "how to place the instrument so that it may show truly all changes in the temperature of the air." And this requires that a few words be said about the mode in which heat acts on the thermometer. These remarks apply equally to the ordinary maximum, minimum, and wet-bulb thermometers.

Precautions in placing thermometers.—A thermometer suspended in the air is affected by heat which reaches it in two different ways: first, by the contact of the air actually around and bathing the bulb, and the temperature of which is to be measured; and, second, by heat which is given off from all solid and other objects around at all times, in all directions, which travels through air and space with the same velocity as light, and, like light, passes freely through some bodies, is absorbed by others, and is reflected by polished metallic surfaces. This last is termed *radiant heat*, or, more properly, simply *radiation*. Now, when the object is to ascertain the temperature of the air, the influence of changes in radiation must be got rid of as much as possible. But it is impossible so to place a thermometer that it is uninfluenced by radiation, for if even it be screened from the heat radiating from surrounding objects (which may be effected to a great extent), it will then radiate off its own heat faster than it can be warmed by the air, and will equally fail therefore to show what is required, viz., the temperature of the air.

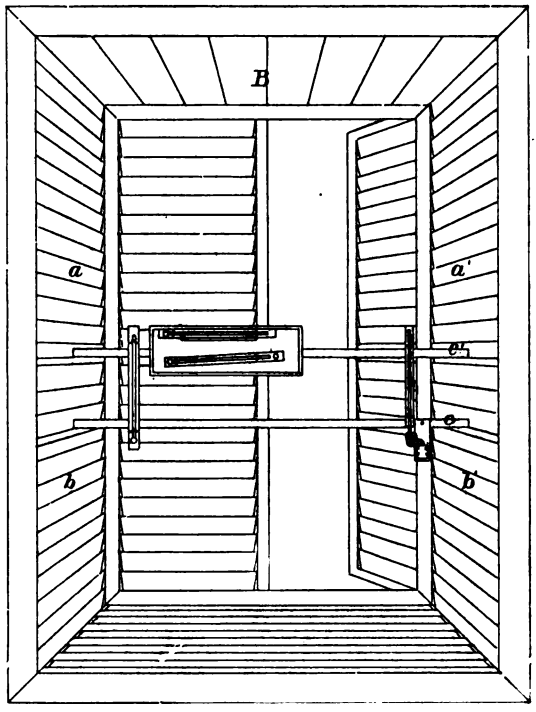
Joule's apparatus.—The alternative, then, is to place the thermometer in such a position that the effects of radiation and air temperature combined may be as nearly as possible identical with those of the latter alone. An arrangement which attains this object accurately has been contrived by Mr. Joule. It consists of a cylindrical copper vessel surrounding a wide tube of the same metal, which is open at both ends. In the axis of the tube is suspended by a filament of unspun silk a very light spiral of metallic wire, which carries a small light mirror above the orifice of the tube. The least current of air passing up or down the tube turns the spiral and the motion is indicated by a ray of light reflected from the mirror. If there be the smallest difference of temperature between the tube and the air around, such currents will be set in motion; when the spiral is motionless in the open tube, it is an indication that there is no such difference in temperature. The temperature of the tube is regulated by filling the cylindrical vessel with water, in which an accurate thermometer is immersed and shows the degree of its temperature.

The accompanying figure shows the pattern of instrument shelter used at the regular stations of the Signal Service. It is erected in accordance with the following instructions:

Select a window fronting the north; remove the lattice blinds, if there be any, and along the exterior jambs of the window place perpendicularly two pieces of lattice-work ("a," "b," "a′" "b′") projecting to a distance of from twenty to twenty-four inches from the panes. Midway between the window and the outer wall of shelter, and at the height of the eye of the observer, pass from one end of the shelter to the other two small wooden transverse bars ("c," "c′"), each an inch square, for the purpose of supporting the instruments, exposed ther-

mometer on the left, maximum and minimum thermometers in the center, and wet bulb thermometer on the right. The blinds that were removed from the jambs, or others provided for the purpose, will be hinged to the side walls, so as to be opened, when necessary, and secured in the middle by an ordinary staple and hook. Ten inches outside of this frame work a second wall, also of lattice work, will be placed with the front opening in the center, in the same manner as the inner wall. The slats of the blinds must be fixed. The whole will be covered with an inclined roof of boards (B), placed at least fifteen or twenty inches above the instruments. The bottom of the shelter will be covered with slats two inches wide, placed one inch apart. The outside of the shelter will be painted with white lead. If the shelter is placed upon the roof, the door must face the north.

FIG. 2.



This style of shelter is best adapted for the use of the Signal Service, inasmuch as its regular stations are mainly in cities where space is limited, but the best exposure is obtained by placing the thermometers, properly sheltered, in an open space out of the vicinity of high buildings and away from obstacles that impede the free circulation of air. Such an exposure is obtained by the use of the Stevenson screen, shown in the figure 3, which has given good results. The louvres are double, sloping in opposite directions, so that while there is access of the air to the inside, the radiant heat and rain are effectually excluded.

This screen should be erected on legs four feet high, and should stand over grass on open ground. It should not be under the shadow of trees nor within twenty feet of any wall.

Precautions in reading thermometers.—To read a thermometer accurately requires some little care.

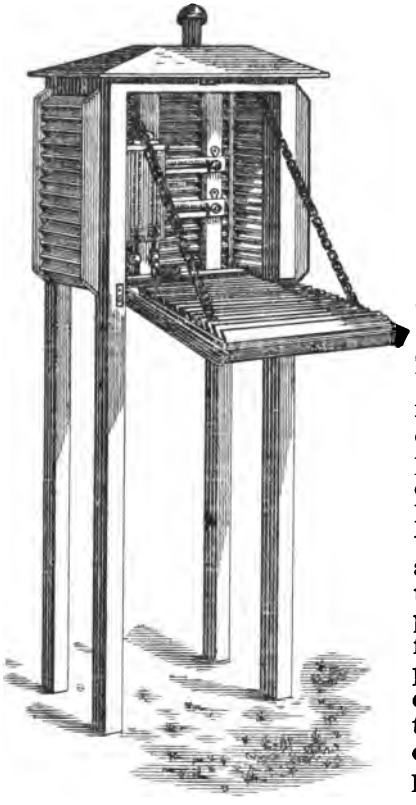
1st. The eye must be exactly at the level of the reading, if the thermometer is vertical; and in all cases must be so situated that a line drawn from the eye to the top of the column would be perpendicular to the column. If the graduation is not on the tubes, and the eye is above the top of the column, however little, the reading will be too low, and *vice versa.* This is a point frequently neglected by careless observers.

2d. The thermometer must be read quickly, and the face and head must not be very near it; otherwise, it will be affected by the warmth radiated from the body.

3d. It must be read to the nearest tenth of a degree by estimation.

Verification.—Verify the zero point at the beginning and end of winter. For this purpose, fill a vessel with snow or pounded ice, immerse the bulb of the thermometer in the middle that it may be surrounded on every side by a layer of several inches slightly pressed around the instrument. The stem must be placed exactly perpendicular, and covered with snow as far up as the freezing-point on the scale. Let it stand so for half an hour or more, and then read it, taking great care to place the eye at the same height as the summit of the mercurial column. If the top of the column does not coincide with the freezing-point of the scale, the exact amount of the difference must be ascertained and the correction immediately applied. At the same time enter in the journal, under its appropriate head, the day on which the experiment is made, *the error*, and the hour at which the application of it was commenced. [It is necessary to add, that since the zero point of the thermometer is not that of the temperature of snow as it is frequently found when exposed to the atmosphere, but that of melting snow, the experiment must be in a place above the temperature of freezing. Instead of snow, pounded ice may be employed.]

FIG. 3.



SELF-REGISTERING THERMOMETERS.

Importance of self-registering thermometers.—Heat being apparently the most effective agent in producing meteorological phenomena, the determination of the highest temperature of the day, and the lowest during the night, is a prime essential to enable an estimate of the climate of any place to be formed. To observe these extremes by means of the ordinary thermometer would be impracticable, from the constant watchfulness which would be necessary. Hence, the utility and importance of self-recording thermometers are evident. A thermometer constructed to *register* the highest temperature is called a *maximum thermometer;* one to show the lowest temperature is termed a *minimum thermometer;* and if made to record both extremes of temperature, it is designated a *maximum and minimum thermometer.*

It has been found that half the sum of the maximum and minimum temperature of each day of twenty-four hours, is not what meteorologists designate the *mean daily temperature*, although it very frequently approximates to it. The mean temperature of the day is understood to be the average of twenty-four consecutive hourly readings of a thermometer; and meteorology now supplies formulæ whereby this result can be deduced from two or three observations only in a day. But the actual mean temperature

of any place has not such an important influence upon life, either animal or vegetable, as the abruptness and magnitude of the variations of temperature. Climate, therefore, should be estimated more by the range of the thermometer than by the average of its indications. Statistics show that with a wide range of the thermometer the mortality greatly increases; and it is now becoming apparent to meteorologists that the daily range of the thermometer marks the effects of temperature on the health of men and the success of crops better than any other meteorological element.

The maximum thermometer used by the Signal Service is manufactured by Mr. James Green, of New York, and is so constructed as to indicate the maximum temperature of the day by the highest point of the mercurial column, thus avoiding the use of a separate index. The bore of the tube has a slight contraction near the bulb, which causes the mercurial column to break at this point when the fluid begins to contract; the column, therefore, remains at the highest point.

The board upon which the maximum and minimum thermometers are supported (see Fig. 2) must be securely fastened with screws, in a horizontal position, upon the transverse bars which support the exposed and wet-bulb thermometers in the instrument shelter.

For the support of the maximum thermometer the long brass pin with a nut will be screwed into the board in the hole to the extreme right. The nut will be taken off and the pin slipped through the hole in the upper end of the instrument, which will be securely fastened by replacing the nut and screwing it tightly. The plain brass pin is then inserted in the hole at the left of the board, and the thermometer placed upon it so as to slightly incline in that direction.

The end of the pin to which the maximum is attached must be occasionally oiled to prevent friction.

The maximum temperature is obtained by noting the number of degrees upon the scale at the top of the column of mercury.

After making an observation the observer will remove the pin at the left, and, taking hold of the thermometer about three inches from the top, will spin it around several times in the direction of the movement of the hands of a watch until the top of the column is brought down to the temperature of the air at the time of observation. Care must be taken not to touch the bulb, and also that the nut is screwed up sufficiently tight to prevent the instrument from striking against the side of the board to which it is fastened. After adjustment, gradually raise the instrument to a horizontal position, and insert the pin as before.

Care should be taken in elevating the thermometer not to raise the bulb too high, as the column of mercury would then run to the upper end of the tube.

This instrument will be read daily at the time of making the 9 p. m. observation, or the last observation of the day, and will then be set for the next day's observation; but should a reading thereof be made at any other time, care must be taken not to change the reading of the instrument.

The alcohol minimum thermometer consists of a glass tube, the bulb and part of the bore of which is filled with perfectly pure spirits of wine, in which moves freely a colored glass index. A slight elevation of the thermometer, bulb uppermost, will cause the glass index to move to the surface (top of the column) of the liquid, where it will remain, unless violently shaken. On a *decrease* of temperature the alcohol recedes, taking with it the glass index; on an *increase* of temperature the alcohol alone ascends in the tube, leaving the end of the index *farthest* from the bulb, indicating the minimum temperature.

Directions for using, &c.—Having placed the glass index at the end of the column of spirit by slightly tilting the thermometer, bulb uppermost, suspend the instrument (in the shade, with the air passing freely to it on all sides) by the two brass plates attached for that purpose, in such manner that the bulb is about half an inch lower than the upper end of the thermometer; then, on a decrease of temperature, the spirits of wine will descend, carrying with it the glass index; on an increase of temperature, however, the spirits of wine will ascend in the tube, leaving that end of the small glass index farthest from the bulb, indicating the minimum temperature. To reset the instrument, simply raise the bulb end of the thermometer a little, as before observed, and the index will again descend to the end of the column, ready for future observations.

Precautions.—1. By no means jerk or shake an alcohol minimum thermometer *when resetting* it, for by so doing it is liable to disarrange the instrument, either by causing the index to leave the spirit, or by separating a portion of the spirit from the main column.

2. As alcohol thermometers have a tendency to read lower by age, owing to the volatile nature of the fluid allowing particles in the form of vapor to rise and lodge in the tube, it becomes necessary to compare them occasionally with a mercurial thermometer whose index error is known, and if the difference be more than a few tenths of a degree, examine well the upper part of the tube to see if any alcohol is hanging in the bore thereof; if so, the detached portion of it can be joined to the main column by swinging the thermometer with a pendulous motion, *bulb downwards.*

3. The spirit column is sometimes much separated by jolting in traveling. If the instrument is in such a condition when received, it should be held by the right hand, bulb downward, and the frame tapped smartly, but cautiously, against the palm of the left hand. The broken thread of spirit will soon begin to join, and by continuing the operation a sufficient time all the bubbles will disappear, and the thermometer become as good as ever.

The top of the thermometer will be fastened by the small brass screw upon the support, while the lower end will be dropped into the notch to the left.

The instrument is read by observing the number of degrees upon the scale where the top of the index rests.

The minimum thermometer will be read at the 9 p. m. observation, or the last observation of the day.

Verification.—Compare the indications of the two thermometers frequently, and especially the spirit thermometer, with those of the exposed thermometer; verify the zeros at least *twice a year*, and, if there is a difference, adjust the zero anew, if the instrument permits, eliminate the correction, as has been stated above for the exposed thermometer, or take this correction into account in the register.

THE ABSORPTION AND RADIATION OF THE SUN'S HEAT BY THE EARTH'S SURFACE.

RADIATION THERMOMETERS.

Solar and terrestrial radiation considered.—The surface of the earth absorbs the heat of the sun during the day and radiates heat into space during the night. The envelope of gases and vapor which we call atmosphere exerts highly important functions upon these processes.

It has been satisfactorily demonstrated that *dry* air is as diathermanous as the vacuum itself; while air *perfectly saturated* with aqueous vapor absorbs more than 5 per cent. of radiant heat, estimated by the thermal unit adopted for the galvanometer indications of the effect upon a thermoelectric pile.

Aqueous vapor, in the form of fog or mist, as is well known, gives a sensation of cold, and interferes with the healthy action of the skin and the lungs, the cause being its property of absorbing heat from the person.

Air containing moisture in an invisible state likewise exerts a remarkable influence in radiating and absorbing heat. By reason of these properties aqueous vapor acts as a kind of blanket upon the ground, and maintains upon it a higher temperature than it would otherwise have. "Regarding the earth as a source of heat, no doubt at least 10 per cent. of its heat is intercepted within ten feet of the surface." Thus vapor—whether transparent and invisible, or visible, as cloud, fog, or mist—is intimately connected with the important operations of solar and terrestrial radiation. Cloudy or humid days diminish the effect upon the soil of solar radiation; similar nights retard the radiation from the earth. A dry atmosphere is the most favorable for the direct transmission of the sun's rays, and the withdrawal of the sun from any region over which the air is dry must be followed by very rapid cooling of the soil. The removal for a single summer night of the aqueous vapor from the atmosphere which covers the earth would be attended by the destruction of every plant which a freezing temperature could kill. In Sahara, where "the soil is fire and the wind is flame," the refrigeration at night is often painful to bear. Ice has been formed in that region at night. In Australia also the *diurnal range* of temperature is very great, amounting commonly to between 40° and 50°. In short, it may be safely predicted that wherever the air is *dry* the daily thermometric range will be great. This, however, is quite different from saying that when the air is *clear* the thermometric range will be great. Great clearness to light is perfectly compatible with great opacity to heat; the atmosphere may be charged with aqueous vapor while a deep-blue sky is overhead, and on such occasions the terrestrial radiation would, notwithstanding the clearness, be intercepted. The great range of the thermometer is attributable to the absence of that protection against gain or loss of heat which is afforded when aqueous vapor is present in the air; and during such weather the rapid abstraction of moisture from the surface of plants and animals is very deleterious to their healthy condition. The nipping of tender plants by frost, even when the air of the garden is some degrees above the freezing temperature, is also to be referred to chilling by radiation. Hence, the practice of gardeners of spreading thin mats of bad radiating material over tender plants is often attended with great benefit.

By means of the process of terrestrial radiation ice is artificially formed in Bengal, where the substance is never formed naturally. Shallow pits are dug, which are partly filled with straw, and on the straw flat pans containing water which had been boiled are exposed to the clear firmament. The water is a very powerful radiant, and sends off its heat into space. The heat thus lost cannot be supplied from the earth, this source being cut off by the non-conducting straw. Before sunrise a cake of ice is formed in each vessel. * * * To produce the ice in abundance the atmosphere must not only be clear, but it must be comparatively free from aqueous vapor.

Considering, therefore, the important consequences attending both terrestrial and solar radiation, it appears that observations from radiation thermometers are of much more utility in judging of climate than is usually supposed. These observations are very scanty, and what few are upon record are not very reliable, principally from bad exposure of the instruments, while the want of uniformity in construction may be another cause. Herschell's actinometer and Pouillet's pyrheliometer, instruments for ascertaining the absolute heating effect of the sun's rays, should, however, be more generally employed by meteorologists. In comparing observations on radiation it should be kept in mind that the difference between a thermometer which, properly confined (or shaded), gives the true temperature of the night air, and one which is permitted to radiate freely towards space must be greater at high elevations than at low ones; because the higher the place the less the thickness of the vapor screen to intercept the radiation.

Solar radiation thermometer.—As the interchange of heat between two bodies by radiation depends upon the relative temperature which they respectively possess, the earth, by the rays transmitted from the sun during the day, must be continually gaining an accession of heat which would be far from being counterbalanced by the opposite effect of its own radiation into space. Hence, from sunrise till two or three hours after mid-day, the earth goes on gradually increasing in temperature, the augmentation being greatest where the surface consists of materials calculated, from their color and texture, to absorb heat, and where it is deficient in moisture, which, by its evaporation, would have a tendency to diminish it. It is, therefore, important to have instruments for measuring the efficacy of solar radiation, apart from those for exhibiting the temperature of the place in the shade.

Fig 4 shows the arrangement of Negretti and Zambra's maximum thermometer for registering the greatest heat of the sun's direct rays, hence

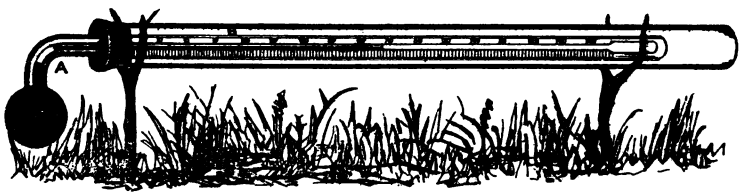


FIG. 4.

called a *solar radiation thermometer.* It has a blackened bulb, the scale divided on its own stem, and the divisions protected by a glass shield. In use it should be placed nearly horizontally, resting on Y supports of wood or metal, with its bulb in the full rays of the sun, resting on grass, and, if possible, so that lateral winds should not strike the bulb; and at a sufficient distance from any wall, so that it does not receive any *reflected* heat from the sun. Some observers place the thermometer as much as two feet from the ground. It would be very desirable if one uniform plan could be recognized; that of placing the instrument as indicated in the figure appears to be most generally adopted, and the least objectionable.

Vacuum solar radiation thermometer.—In order that the heat absorbed by the blackened bulb of the solar radiation thermometer may not in part be carried off by the currents of air which would come into contact with it, the instrument has been improved by Messrs. Negretti and

Zambra into the *vacuum solar radiation thermometer*, as illustrated by Fig. 5:

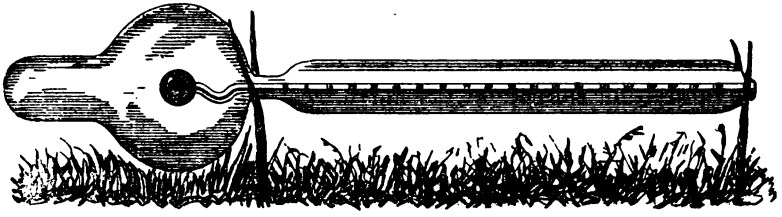


FIG. 5.

This consists of a blackened bulb radiation thermometer, inclosed in a glass tube and globe, from which all air is exhausted. Thus protected from the loss ot heat which would ensue if the bulb were exposed, its indications are from 20° to 30° higher than when placed side by side with a similar instrument with the bulb exposed to the passing air. At times when the air has been in rapid motion, the difference between the reading of a thermometer giving the true temperature of the air in the shade, and an ordinary solar radiation thermometer, has been 20° only, while the difference between the air temperature and the reading of a radiation thermometer in vacuo has been as large as 50°. It is also found that the readings are almost identical at distances from the earth varying from six inches to eighteen inches. By the use of this improvement it is hoped that the amounts of solar radiation at different places may be rendered comparable; hitherto they have not been so; the results found at different places cannot be compared, as the bulbs of the thermometers are under very different circumstances as to exposure and currents of air. Important results are anticipated from this arrangement. The observations at different places are expected to present more agreement. Observers would do well to note carefully the effect of any remarkable degree of intensity in the solar heat upon particular plants, crops, fruit or other tre es.

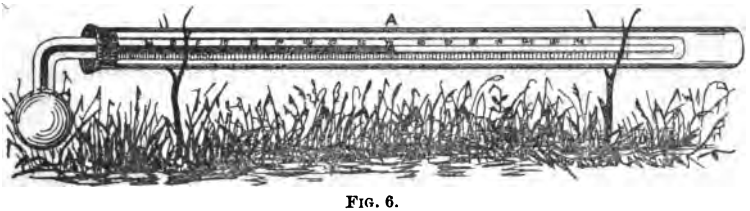


FIG. 6.

Terrestrial radiation thermometer is an alcohol minimum thermometer, with the graduations etched upon the stem, and protected by a glass shield, as shown in figure 6, instead of being mounted on a frame. The bulb is transparent; that is to say, the spirit is not colored.

In use, it should be placed with its bulb fully exposed to the sky, resting on grass, the stem being supported by little forks of wood. The precautions required with this thermometer are similar to those for ordinary spirit thermometers.

HYGROMETRY.

Humidity.—The condition of the air, as regards moisture, involves two distinct elements, (1) the amount of vapor present in the air, and (2) the ratio of this to the amount which would saturate the air at the actual

temperature. It is upon the second of these elements that our sensations of dryness and moisture chiefly depend, and it is this element which meteorologists have agreed to denote by the term *humidity;* or, as it is sometimes called, *relative humidity.* It is usually expressed as a percentage. For example, if the weight of vapor present is seven-tenths of that required for saturation, the humidity is said to be 70 per cent.

The words *humid* and *moist*, as applied to air in ordinary language, nearly correspond to this technical use of the word *humidity;* and air is usually said to be dry when its *humidity* is considerably below the average. In treatises on physics, "dry air" usually denotes air whose humidity is zero.

The air in a room heated by a hot stove contains as much vapor, weight for weight, as the open air outside; but it is drier, because its capacity for vapor is greater. In like manner, the air is drier at noon than at midnight, though the amount of vapor present is about the same; and it is, for the most part, drier in summer than in winter, though the amount of vapor present is much greater. Bearing in mind that a cubic foot of air is able to take up the same amount of vapor as a cubic foot of empty space, the *humidity of the air* may be defined as *the weight of aqueous vapor in a given volume of air*, expressed *as a percentage of the weight of vapor at saturation which would occupy the same volume at the actual temperature.* Also, since aqueous vapor nearly fulfills Boyle's law, the humidity of the air may be obtained by comparing the *tension* of the vapor present in the air with the *maximum tension* for the actual temperature.

Dew-point.—When air containing aqueous vapor is gradually cooled at constant pressure, its density increases, and the rate of increase is sensibly the same for the vapor as for the dry air with which it is mixed (inasmuch as vapors not in contact with their liquids nearly fulfill Gay-Lussac's law), until a point is reached at which the density of the vapor becomes equal to the maximum density corresponding to the temperature. This temperature is called the dew-point of the given mass, and any further reduction of temperature will be accompanied by the condensation of a portion of the vapor, which will take the form of dew, rain, snow, or hoar-frost, according to circumstances. If the cooling is produced by the low temperature of the sides of the containing vessel, the deposit will be dew or hoar-frost, according as the temperature of the sides is above or below the freezing-point. If the cooling takes place in the interior of the mass of air, the deposit will be rain or snow, according as the temperature of deposition is above or below the freezing point.

Hygroscopes.—Anything which serves to give rough indications of the state of the air as regards moisture, may be called a *hygroscope.* Many substances, especially those which are composed of organic tissue, have the property of absorbing the moisture of the surrounding air until they attain a condition of equilibrium, such that their affinity for the moisture absorbed is exactly equal to the force with which the latter tends to evaporate. Hence it follows that, according to the dampness or dryness of the air, such a substance will absorb or give up vapor, either of which processes is always attended with a variation in the dimensions of the body. The nature of this variation depends upon the peculiar structure of the substance; thus, for instance, bodies formed of filaments exhibit a greater increase in the direction of their breadth than of their length. Membraneous bodies, on the other hand, such as paper or parchment, formed by an interlacing of fibers in all directions,

composed of twisted fibers, as ropes and strings, swell under the action of moisture, grow shorter, and are more tightly twisted. The opposite is the case with catgut, which is often employed in popular hygroscopes.

HYGROMETERS.

Instruments intended for furnishing precise measurements of the state of the air as regards moisture are called hygrometers. They may be divided into four classes:

1st. Hygrometers of absorption, which should rather be called hygroscopes.

2d. Hygrometers of condensation, or dew-point instruments.

3d. Hygrometers of evaporation, or wet and dry-bulb thermometers.

4th. Chemical hygrometers, for directly measuring the weight of vapor in a given volume of air.

The third class is the one used in the Signal Service.

PSYCHROMETER.

60. The wet-bulb thermometer will be placed in the same shelter as the exposed thermometer, as shown in Figure 1. The cistern will be kept supplied with pure rain-water at all times when the temperature of the air is above the freezing-point, and the cover of the bulb must be changed every month, and the bulb carefully cleaned. The cover may be washed as often as necessary, without removal, by means of a jet of clean water from a small syringe.

When the temperature of the air is below the freezing point, the wicking must be removed and water must be emptied from the cistern. In making an observation the wet-bulb will be moistened with cold water (applied with a camel's hair brush), and the instant the mercury has reached its minimum its height will be noted.

Self-registering hygrometer.—A maximum thermometer and a minimum thermometer, each fitted up as a wet-bulb thermometer, record the highest and lowest temperature of evaporation during the interval of observation. A mercurial maximum, and an alcohol minimum, answer best.

Verification.—The two thermometers must be carefully compared from time to time, and if a difference is found, the instruments must be adjusted, or it must be taken into the account, and the observations corrected when entered in the journal.

From Tables I to VI the dew-point and relative humidity may be obtained from the reading of the dry and wet-bulb thermometers.

USE OF THE TABLES.

Tables I–V give the temperature of the dew-point for the actual pressures 30.00, 27.00, 24.00, 21.00, and 18.00 inches. The vertical argument, as given in the left-hand column of each page, is the temperature of the air or the reading of the exposed or dry-bulb thermometer (**t**). The horizontal argument, as given at the top of each page, is the depression of the wet-bulb thermometer (**t′**) or the difference (**t–t′**) between the readings of the dry and wet-bulb thermometers.

The actual barometric pressure at the station will determine which of Tables I–V is to be used; select always the table for the nearest actual pressure. The supplementary tables on pages 1 and 3 of Tables I–III will be used for the few cases to which they are applicable.

Table VI gives the relative humidity for all pressures. The vertical argument is the temperature of the air (**t**). The horizontal argument is the depression of the dew-point (**d**), or the difference (**t–d**) between the readings of the exposed thermometer and the dew-point; the latter will be obtained from the preceding Tables I–V.

EXAMPLES.

1. Actual pressure 27.36 in., the exposed thermometer reads 57° F., the wet-bulb thermometer 48° F. Find the temperature of the dew-point and the relative humidity.

Air temperature, (**t**) =57°
Wet-bulb reading, (**t′**) =48°
Depression of the wet-bulb, (**t–t′**) = 9°
From Table II, for 27.0 in. we obtain dew-point, (**d**) =38°
Depression of the dew-point, (**t–d**) =19°
From Table VI we obtain relative humidity, =49 p. ct.

2. Actual pressure 28.20 in., the exposed thermometer reads 26°, the wet-bulb thermometer 19°. Find the temperature of the dew-point and relative humidity.

Air temperature, (**t**) =26°
Wet-bulb reading, (**t′**) =19°
Depression of the wet-bulb, (**t–t′**) = 7°
Dew-point, (**d**)= —9° by Table I, for 28.0 in.
Depression of the dew-point, (**t–d**) =35°
Relative humidity, =20 p. ct. by Table VI.

TABLE I. DEW-POINT.

Barometric pressure 30.0 *inches.*

Air temp.	Depression of the wet-bulb thermometer (t − t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
							Barometric pressure, 29.0 inches.								
							t	4							
							+10	−24							
							11	21	5						
							12	18							
							13	14							
−20°	−20						14	−12	−28						−20°
19	19						15		23						19
18	18						16		21	6	7	8	9	t	18
17	17						17		17						17
−16	−16						18		13						−16
							19		−10	−27				+19	
−15	−15	−31					+20			21				20	−15
14	14	29								17				21	14
13	13	27								13				22	13
12	12	26					t	4	5	− 9	−25			23	12
−11	−11	24									19			24	−11
											15			25	
−10	−10	−23									12			26	−10
9	9	21								6	− 8	−23		27	9
8	8	19										17		28	8
7	7	18										12		29	7
− 6	− 6	16										− 9	−25	+30	− 6
− 5	− 5	−15	−31												− 5
4	4	13	29								7	8	9	t	4
3	3	12	26												3
2	2	11	23												2
− 1	− 1	− 9	−21												− 1
							Barometric pressure, 28.0 inches.								
0	0	− 8	−19												− 0
+ 1	+ 1	6	17												+ 1
2	2	5	15				t	4							2
3	3	4	13	−30											3
4	4	− 3	−12	−26											4
							+10	−21							
+ 5	+ 5	− 1	−10	−23			11	19	5						+ 5
6	6	0	8	21			12	16							6
7	7	+ 1	7	18			13	13							7
8	8	2	5	15			14	−11	−24						8
9	9	3	− 4	−13	−29		15		21						9
							16		18	6	7	8	9	t	
+10	+10	+ 5	− 2	−11	−26		17		14						+10
11	11	6	0	9	23		18		11						11
12	12	7	+ 1	7	20		19		− 9	−23					12
13	13	8	2	5	16		+20			18				+19	13
14	14	9	4	− 3	−14	−31				14				20	14
										11				21	
+15	+15	+11	+ 6	− 1	−11	−26	t	4	5	− 8	−22			22	+15
16	16	12	7	0	9	23					16			23	16
17	17	13	8	+ 2	6	19					13			24	17
18	18	14	9	4	4	15				6	9			25	18
19	19	15	11	5	− 2	−12	−31				− 6	−19		26	19
												14		27	
+20	+20	+16	+12	+ 7	0	− 9	−24					10		28	+20
21	21	17	13	9	+ 2	6	19					− 6	−20	29	21
22	22	19	15	10	4	4	15							+30	22
23	23	20	16	12	6	− 1	11	−29							23
24	24	21	17	13	8	+ 1	− 8	−23			7	8	9	t	24
+25	+25	+22	+18	+15	+ 9	+ 3	− 5	−18							+25
26	26	23	20	16	11	5	− 2	14							26
27	27	24	21	17	13	7	0	10	−27						27
28	28	25	22	18	14	9	+ 3	6	20						28
29	29	26	23	20	16	11	5	− 3	−15						29
+30	+30	+27	+24	+21	+17	+13	+ 7	− 1	−11	−30					+30
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE I. DEW-POINT.

Barometric pressure, 30.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t—t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
+30°	+30°	+27°	+24°	+21°	+17°	+13°	+ 7°	− 1°	−11°	−30°					+30°
31	31	28	25	22	18	14	9	+ 2	− 7	−23					31
32	32	29	26	23	20	16	11	5	− 3	−17					32
33	33	30	27	24	21	17	13	7	− 1	−12	−32				33
34	34	31	28	26	22	19	15	9	+ 2	− 7	−23				34
+35	+35	+32	+29	+26	+24	+20	+16	+11	+ 5	− 3	−17				+35
36	36	33	30	27	24	21	18	13	8	− 1	−12	−32			36
37	37	34	32	29	25	21	19	15	9	+ 3	− 7	−23			37
38	38	35	33	30	26	23	19	17	12	6	− 3	−16			38
39	39	36	34	31	28	24	20	16	14	8	0	−11	−31		39
+40	+40	+37	+35	+32	+29	+26	+22	+18	+12	+10	+ 3	− 6	−22		+40
41	41	39	36	33	30	27	23	19	14	8	6	− 2	−15		41
42	42	40	37	34	31	28	25	21	16	10	3	+ 2	− 9	−29	42
43	43	41	38	35	33	30	26	22	18	13	6	− 3	− 5	−20	43
44	44	42	39	37	34	31	27	24	20	15	9	+ 1	−12	−13	44
+45	+45	+43	+40	+38	+35	+32	+29	+25	+21	+17	+11	+ 4	− 7	−27	+45
46	46	44	41	39	36	33	30	27	23	19	14	7	− 2	−18	46
47	47	45	43	40	37	35	32	28	25	21	16	10	+ 2	−11	47
48	48	46	44	41	39	36	33	30	26	22	18	12	5	− 6	48
49	49	47	45	42	40	37	34	31	28	24	20	15	8	− 1	49
+50	+50	+48	+46	+43	+41	+38	+36	+33	+29	+26	+22	+17	+11	+ 3	+50
51	51	49	47	45	42	40	37	34	31	27	23	19	13	6	51
52	52	50	48	46	43	41	38	35	32	29	25	21	16	9	52
53	53	51	49	47	44	42	40	37	34	30	27	23	18	12	53
54	54	52	50	48	46	43	41	38	35	32	28	24	20	15	54
+55	+55	+53	+51	+49	+47	+45	+42	+39	+36	+33	+30	+26	+22	+17	+55
56	56	54	52	50	48	46	43	41	38	35	32	28	24	19	56
57	57	55	53	51	49	47	45	42	39	36	33	30	26	22	57
58	58	56	54	52	50	48	46	43	41	38	35	31	28	24	58
59	59	57	55	53	51	49	47	45	42	39	36	33	29	26	59
+60	+60	+58	+56	+54	+52	+50	+48	+46	+43	+41	+38	+35	+31	+28	+60
61	61	59	57	56	54	52	49	47	45	42	39	36	33	29	61
62	62	60	58	57	55	53	51	48	46	43	41	38	35	31	62
63	63	61	60	58	56	54	52	50	47	45	42	39	36	33	63
64	64	62	61	59	57	55	53	51	49	46	44	41	38	35	64
+65	+65	+63	+62	+60	+58	+56	+54	+52	+50	+48	+45	+42	+39	+36	+65
66	66	64	63	61	59	57	55	53	51	49	46	44	41	38	66
67	67	65	64	62	60	58	56	54	52	50	48	45	43	40	67
68	68	66	65	63	61	59	58	56	54	51	49	47	44	41	68
69	69	67	66	64	62	61	59	57	55	53	50	48	45	43	69
+70	+70	+68	+67	+65	+63	+62	+60	+58	+56	+54	+52	+49	+47	+44	+70
71	71	69	68	66	65	63	61	59	57	55	53	51	48	46	71
72	72	71	69	67	66	64	62	60	58	56	54	52	50	47	72
73	73	72	70	68	67	65	63	61	60	58	56	53	51	49	73
74	74	73	71	69	68	66	64	63	61	59	57	55	52	50	74
+75	+75	+74	+72	+70	+69	+67	+65	+64	+62	+60	+58	+56	+54	+51	+75
76	76	75	73	71	70	68	67	65	63	61	59	57	55	53	76
77	77	76	74	72	71	69	68	66	64	62	60	58	56	54	77
78	78	77	75	74	72	70	69	67	65	64	62	60	58	55	78
79	79	78	76	75	73	71	70	68	66	65	63	61	59	57	79
+80	+80	+79	+77	+76	+74	+73	+71	+69	+68	+66	+64	+62	+60	+58	+80
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE I.

Air temp. t	13	14	15	16
+30				
31				
32				
33				
34				
+35				
36				
37				
38				
39				
+40				
41				
42	−29			
43	−20			
44	**−13**			
+45	−27	**−26**		
46	−18			
47	−11			
48	− 6	−25		
49	− 1	−16		
+50	+ 3	− 9		
51	6	− 3	−22	
52	9	+ 1	−13	
53	12	5	− 7	−28
54	15	8	− 2	−18
+55	+17	+11	+ 3	−10
56	19	14	7	− 4
57	22	17	10	+ 1
58	24	19	13	6
59	26	21	16	9
+60	+28	+23	+18	+12
61	29	25	21	15
62	31	27	23	18
63	33	29	25	20
64	35	31	27	23
+65	+36	+33	+29	+25
66	38	35	31	27
67	40	36	33	29
68	41	38	35	31
69	43	40	37	33
+70	+44	+41	+38	+35
71	46	43	40	37
72	47	45	42	39
73	49	46	43	40
74	50	48	45	42
+75	+51	+49	+46	+44
76	53	50	48	45
77	54	52	49	47
78	55	53	51	48
79	57	55	52	50
+80	+58	+56	+54	+51
	13	14	15	16

TABLE I. DEW-POINT.

Barometric pressure, 30.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t—t').														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
+80	+80	+79	+77	+76	+74	+73	+71	+69	+68	+66	+64	+62	+60	+58	+80
81	81	80	78	77	75	74	72	70	69	67	65	63	61	60	81
82	82	81	79	78	76	75	73	72	70	68	66	65	63	61	82
83	83	82	80	79	77	76	74	73	71	69	68	66	64	62	83
84	84	83	81	80	78	77	75	74	72	70	69	67	65	63	84
+85	+85	+84	+82	+81	+79	+78	+76	+75	+73	+72	+70	+68	+66	+65	+85
86	86	85	83	82	80	79	77	76	74	73	71	69	68	66	86
87	87	86	84	83	81	80	79	77	75	74	72	70	69	67	87
88	88	87	85	84	82	81	80	78	77	75	73	72	70	68	88
89	89	88	86	85	84	82	81	79	78	76	75	73	71	69	89
+90	+90	+89	+87	+86	+85	+83	+82	+80	+79	+77	+76	+74	+72	+71	+90
91	91	90	88	87	86	84	83	81	80	78	77	75	74	72	91
92	92	91	89	88	87	85	84	82	81	79	78	76	75	73	92
93	93	92	90	89	88	86	85	83	82	81	79	77	76	74	93
94	94	93	91	90	89	87	86	85	83	82	80	79	77	75	94
+95	+95	+94	+92	+91	+90	+88	+87	+86	+84	+83	+81	+80	+78	+77	+95
96	96	95	93	92	91	89	88	87	85	84	82	81	79	78	96
97	97	96	94	93	92	90	89	88	86	85	83	82	80	79	97
98	98	97	95	94	93	92	90	89	87	86	85	83	82	80	98
99	99	98	96	95	94	93	91	90	88	87	86	84	83	81	99
+100	+100	+ 99	+ 97	+ 96	+95	+94	+92	+91	+90	+88	+87	+85	+84	+82	+100
101	101	100	98	97	96	95	93	92	91	89	88	86	85	83	101
102	102	101	99	98	97	96	94	93	92	90	89	87	86	85	102
103	103	102	100	99	98	97	95	94	93	91	90	89	87	86	103
104	104	103	101	100	99	98	96	95	94	92	91	90	88	87	104
+105		+104	+103	+101	+100	+ 99	+ 97	+ 96	+95	+ 94	+92	+ 91	+ 89	+ 88	+105
106			104	102	101	100	98	97	96	95	93	92	90	89	106
107				103	102	101	100	98	97	96	94	93	92	90	107
108					103	102	101	99	98	97	95	94	93	91	108
109						103	102	100	99	98	96	95	94	92	109
+110							+103	+101	+100	+ 99	+ 97	+ 96	+ 95	+ 93	+110
111								102	101	100	99	97	96	95	111
112									102	101	100	98	97	96	112
113										102	101	99	98	97	113
114											102	100	99	98	114
+115												+101	+100	+ 99	+115
116													101	100	116
117														101	117
118															118
119															119
+120															+120
121															121
122															122
123															123
124															124
+125															+125
126															126
127															127
128															128
129															129
+130															+130
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE I. DEW-POINT.

Barometric pressure, 30.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t—t′).														Air temp.
t	13	14	15	16	17	18	19	20	21	22	23	24	25	26	t
+ 80	+ 58	+ 56	+ 54	+ 51	+ 49	+ 46	+ 43	+ 40	+ 37	+ 33	+ 29	+ 24	+ 18	+ 11	+ 80
81	60	57	55	53	50	48	45	42	39	35	31	27	21	15	81
82	61	59	57	54	52	49	47	44	41	37	34	29	24	19	82
83	62	60	58	56	53	51	48	46	43	39	36	31	27	22	83
84	63	61	59	57	55	53	50	47	44	41	38	34	30	25	84
+ 85	+ 65	+ 63	+ 61	+ 59	+ 56	+ 54	+ 52	+ 49	+ 46	+ 43	+ 40	+ 36	+ 32	+ 28	+ 85
86	66	64	62	60	58	55	53	51	48	45	42	38	34	30	86
87	67	65	63	61	59	57	55	52	50	47	44	40	37	33	87
88	68	66	65	63	60	58	56	54	51	49	46	42	39	35	88
89	69	68	66	64	61	60	58	55	53	50	47	44	41	38	89
+ 90	+ 71	+ 69	+ 67	+ 65	+ 63	+ 61	+ 59	+ 57	+ 54	+ 52	+ 49	+ 46	+ 43	+ 40	+ 90
91	72	70	68	66	65	63	60	58	56	54	51	48	45	42	91
92	73	71	70	68	66	64	62	60	57	55	52	50	47	44	92
93	74	73	71	69	67	65	63	61	59	57	54	52	49	46	93
94	75	74	72	70	68	67	65	63	60	58	56	53	51	48	94
+ 95	+ 77	+ 75	+ 73	+ 72	+ 69	+ 68	+ 66	+ 64	+ 62	+ 60	+ 57	+ 55	+ 52	+ 50	+ 95
96	78	76	74	73	71	69	67	65	63	61	59	56	54	51	96
97	79	77	76	74	72	70	69	67	65	63	60	58	56	53	97
98	80	78	77	75	73	72	70	68	66	64	62	60	57	55	98
90	81	80	78	76	75	73	71	69	67	65	63	61	59	56	99
+100	+ 82	+ 81	+ 79	+ 78	+ 76	+ 74	+ 72	+ 71	+ 69	+ 67	+ 65	+ 63	+ 60	+ 58	+100
101	83	82	80	79	77	75	74	72	70	68	66	64	62	60	101
102	85	83	81	80	78	77	75	73	71	69	68	66	64	61	102
103	86	84	83	81	80	78	76	74	73	71	69	67	65	63	103
104	87	85	84	82	81	79	77	76	74	72	70	68	66	64	104
+105	+ 88	+ 86	+ 85	+ 83	+ 82	+ 80	+ 79	+ 77	+ 75	+ 73	+ 72	+ 70	+ 68	+ 66	+105
106	89	88	86	85	83	82	80	78	77	75	73	71	69	67	106
107	90	89	87	86	84	83	81	80	78	76	74	72	71	69	107
108	91	90	88	87	85	84	82	81	79	77	76	74	72	70	108
109	92	91	90	88	87	85	84	82	80	79	77	75	73	71	109
+110	+ 93	+ 92	+ 91	+ 89	+ 88	+ 86	+ 85	+ 83	+ 82	+ 80	+ 78	+ 76	+ 75	+ 73	+110
111	95	93	92	90	89	87	86	84	83	81	80	78	76	74	111
112	96	94	93	91	90	89	87	86	84	82	81	79	77	76	112
113	97	95	94	93	91	90	88	87	85	84	82	80	79	77	113
114	98	96	95	94	92	91	89	88	86	85	83	82	80	78	114
+115	+ 99	+ 98	+ 96	+ 95	+ 93	+ 92	+ 91	+ 89	+ 88	+ 86	+ 84	+ 83	+ 81	+ 79	+115
116	100	99	97	96	95	93	92	90	89	87	86	84	83	81	116
117	101	100	98	97	96	94	93	91	90	88	87	85	84	82	117
118		101	99	98	97	95	94	93	91	90	88	87	85	83	118
119			101	99	98	97	95	94	92	91	89	88	86	85	119
+120				+100	+ 99	+ 98	+ 96	+ 95	+ 93	+ 92	+ 90	+ 89	+ 87	+ 86	+120
121					100	99	97	96	95	93	92	90	89	87	121
122						100	98	97	96	94	93	91	90	88	122
123							100	98	97	95	94	93	91	89	123
124								99	98	97	95	94	92	91	124
+125									+ 99	+ 98	+ 96	+ 95	+ 93	+ 92	+125
126										99	97	96	95	93	126
127											99	97	96	94	127
128												98	97	96	128
129													98	97	129
+130														98	+130
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	

TABLE I. DEW-POINT.

Barometric pressure, 30.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t-t').														Air temp.
t	26	27	28	29	30	31	32	33	34	35	36	37	38	39	t
+ 80	+11	− 3	−29												+ 80
81	15	+ 4	13												81
82	19	10	− 3	−27											82
83	22	14	+ 5	11											83
84	25	18	11	− 2	−25										84
+ 85	+28	+22	+15	+ 6	−10										+ 85
86	30	25	19	12	0	−23									86
87	33	28	22	15	+ 7	− 8									87
88	35	30	26	20	13	+ 1	−20								88
89	38	33	28	23	17	8	− 6								89
+ 90	+40	+36	+31	+26	+21	+13	+ 3	−17							+ 90
91	42	38	34	29	24	18	9	− 4							91
92	44	40	36	32	27	22	14	+ 4	−14						92
93	46	43	39	35	30	25	19	11	− 2	−29					93
94	48	45	41	37	33	28	23	16	+ 6	−10					94
+ 95	+50	+47	+43	+40	+36	+31	+26	+20	+12	0	−24				+ 95
96	51	49	45	42	38	34	29	24	17	+ 8	− 7				96
97	53	50	47	44	41	37	32	27	21	14	+ 3	−18			97
98	55	52	49	46	43	39	35	30	25	19	10	− 4			98
99	56	54	51	48	45	42	38	33	28	23	15	+ 5	−13		99
+100	+58	+56	+53	+50	+47	+44	+40	+36	+31	+26	+20	+12	− 1	−30	+100
101	60	57	55	52	49	46	43	39	34	29	24	17	+ 7	− 9	101
102	61	59	57	54	51	48	45	41	37	33	28	22	14	+ 2	102
103	63	61	58	56	53	50	47	44	40	36	31	25	19	10	103
104	64	62	60	57	55	52	49	46	42	39	34	29	23	16	104
+105	+66	+64	+62	+59	+57	+54	+51	+48	+45	+41	+37	+32	+27	+21	+105
106	67	65	63	61	58	56	53	50	47	44	40	35	30	25	106
107	69	67	65	62	60	58	55	52	49	46	42	38	34	28	107
108	70	68	66	64	62	59	57	54	51	48	45	41	37	32	108
109	71	70	68	66	63	61	58	56	53	50	47	43	39	35	109
+110	+72	+71	+69	+67	+65	+63	+60	+58	+55	+52	+49	+46	+42	+38	+110
111	74	73	71	69	67	64	62	60	57	54	51	48	45	41	111
112	76	74	72	70	68	66	64	61	59	56	53	50	47	43	112
113	77	75	73	72	70	67	65	63	61	58	55	52	49	46	113
114	78	77	75	73	71	69	67	65	62	60	57	54	51	48	114
+115	+79	+78	+76	+74	+72	+70	+68	+66	+64	+62	+59	+56	+54	+51	+115
116	81	79	77	76	74	72	70	68	66	63	61	58	56	53	116
117	82	81	79	77	75	73	71	69	67	65	63	60	58	55	117
118	83	82	80	78	77	75	73	71	69	67	64	62	59	57	118
119	85	83	81	80	78	76	74	72	70	68	66	64	61	59	119
+120	+86	+85	+83	+81	+79	+78	+76	+74	+72	+70	+68	+65	+63	+61	+120
121	87	86	84	82	81	79	77	75	73	71	69	67	65	62	121
122	88	87	85	84	82	80	79	77	75	73	71	69	66	64	122
123	89	88	87	85	83	82	80	78	76	74	72	70	68	66	123
124	91	89	88	86	85	83	81	79	78	76	74	72	70	67	124
+125	+92	+91	+89	+87	+86	+84	+83	+81	+79	+77	+75	+73	+71	+69	+125
126	93	92	90	89	87	86	84	82	80	79	77	75	73	71	126
127	94	93	92	90	88	87	85	84	82	80	78	76	74	72	127
128	96	94	93	91	90	88	86	85	83	81	80	78	76	74	128
129	97	96	94	92	91	89	88	86	85	83	81	79	77	75	129
+130	+98	+97	+95	+94	+92	+91	+89	+87	+86	+84	+82	+81	+79	+77	+130
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	

TABLE II. DEW-POINT.

Barometric pressure, 27.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
							Barometric pressure, 26.0 inches.								
							t	4	5						
							+10	−17							
							11	15							
							12	−13	−27						
							13		22						
−20	−20						14		19	6	7	8	9	t	−20
19	19						15		16						19
18	18						16		14						18
17	17						17		−10	−24				+17	17
−16	−16	−31					18			20				18	−16
							19			17				19	
−15	−15	−29					20			13				20	−15
14	14	27					21			10	−24			21	14
13	13	26					+22			− 7	20			22	13
12	12	24									15			23	12
−11	−11	−23					t	4	5	6	11			24	−11
											8	−21		25	
−10	−10	−21									− 5	16		26	−10
9	9	19										12		27	9
8	8	18									7	8	−22	28	8
7	7	17										5	17	29	7
− 6	− 6	−15	−30									− 2	−12	+30	− 6
− 5	− 5	−14	−27									8	9	t	− 5
4	4	12	25												4
3	3	11	28				**Barometric pressure, 25.0 inches.**								3
2	2	10	21												2
− 1	− 1	− 8	−19												− 1
0	0	− 7	−17				t	4	5						0
+ 1	+ 1	6	15	−30											+ 1
2	2	4	13	27			+10	−16							2
3	3	3	12	24			11	14							3
4	4	− 2	−10	−21			12	−11	−23						4
							13		20						
+ 5	+ 5	− 1	− 8	−19			14		17						+ 5
6	6	0	6	16			15		14	6					6
7	7	+ 2	5	14	−29		16		12						7
8	8	3	4	12	25		17		− 9	−21					8
9	9	4	− 2	−10	−22		18			17	7	8	9	t	9
							19			14					
+10	+10	+ 5	− 1	− 8	−19		20			11					+10
11	11	6	+ 1	7	17		21			8				+20	11
12	12	8	2	5	14	−30	+22			− 5	−20			21	12
13	13	9	4	3	11	25					16			22	13
14	14	10	5	− 1	− 9	−21					13			23	14
											8			24	
+15	+15	+11	+ 6	0	− 7	−18	t	4	5	6	6	−17		25	+15
16	16	12	8	+ 2	3	16					− 3	12		26	16
17	17	13	9	4	5	12	−28					9		27	17
18	18	15	10	6	− 1	9	23				7	6	−18	28	18
19	19	16	11	7	+ 1	− 7	−19					− 3	14	29	19
												0	− 9	+30	
+20	+20	+17	+13	+ 8	+ 3	− 5	−15					8	9	t	+20
21	21	18	14	10	5	− 2	12	−28							21
22	22	19	15	11	6	0	9	23							22
23	23	20	16	13	8	+ 2	6	18							23
24	24	21	18	14	10	4	− 3	−13							24
+25	+25	+22	+19	+15	+11	+ 6	− 1	−10	−25						+25
26	26	23	20	17	13	8	+ 2	7	19						26
27	27	24	21	18	14	10	4	4	15						27
28	28	25	22	19	16	11	6	− 1	11	−27					28
29	29	26	24	20	17	13	8	+ 1	− 7	−21					29
+30	+30	+27	+25	+22	+18	+15	+10	+ 4	− 4	−15					+30
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE II. **DEW-POINT.**

Barometric pressure, 27.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
+30	+30	+27	+25	+22	+18	+15	+10	+ 4	− 4	−15					+30
31	**31**	28	26	23	20	16	11	6	− 1	11	−27				31
32	32	**29**	27	24	21	17	13	8	+ 2	7	20				32
33	33	30	**28**	25	22	19	15	10	4	− 4	15				33
34	34	31	29	**26**	24	20	16	12	6	0	−10	−28			34
+35	+35	+32	+30	+27	**+25**	+21	+18	+14	+ 8	+ 2	− 6	−20			+35
36	36	34	31	28	25	**23**	19	16	11	5	− 3	14			36
37	37	35	32	29	26	23	**21**	17	13	7	0	9	−26		37
38	38	36	33	30	27	24	20	**19**	15	10	+ 4	5	19		38
39	39	37	34	31	28	25	22	18	**16**	12	6	− 2	−13		39
+40	+40	+38	+35	+32	+30	+27	+23	+19	+15	**+14**	+ 8	+ 2	− 8	−23	+40
41	41	39	36	34	31	28	25	21	17	12	**11**	5	− 4	16	41
42	42	40	37	35	32	29	26	23	19	14	8	**8**	0	11	42
43	43	41	38	36	33	30	27	24	20	16	10	4	**+3**	6	43
44	44	42	40	37	34	32	29	25	22	18	13	6	− 3	**−2**	44
+45	+45	+43	+41	+38	+36	+33	+30	+27	+23	+20	+15	+ 9	+ 1	−10	+45
46	46	44	42	39	37	34	31	28	25	21	17	12	5	− 5	46
47	47	45	43	40	38	36	33	30	26	23	19	14	8	0	47
48	48	46	44	42	39	37	34	31	28	24	21	16	10	+ 3	48
49	49	47	45	43	40	38	35	32	29	26	22	18	13	6	49
+50	+50	+48	+46	+44	+42	+39	+36	+34	+31	+27	+24	+20	+15	+ 9	+50
51	51	49	47	45	43	40	38	35	32	29	26	22	17	12	51
52	52	50	48	46	44	42	39	36	34	30	27	24	19	14	52
53	53	51	49	47	45	43	40	38	35	32	29	25	21	17	53
54	54	52	50	48	46	44	42	39	36	33	30	27	23	19	54
+55	+55	+53	+51	+49	+47	+45	+43	+40	+38	+35	+32	+29	+25	+21	+55
56	56	54	52	50	48	46	44	42	39	36	33	30	27	23	56
57	57	55	53	52	50	47	45	43	40	38	35	32	28	25	57
58	58	56	54	53	51	49	46	44	42	39	36	33	30	27	58
59	59	57	55	54	52	50	48	45	43	40	38	35	32	28	59
+60	+60	+58	+56	+55	+53	+51	+49	+47	+44	+42	+39	+36	+33	+30	+60
61	61	59	58	56	54	52	50	48	46	43	41	38	35	32	61
62	62	60	59	57	55	53	51	49	47	45	42	39	36	33	62
63	63	61	60	58	56	54	52	50	48	46	43	41	38	25	63
64	64	62	61	59	57	55	54	52	49	47	45	42	40	37	64
+65	+65	+63	+62	+60	+58	+56	+55	+53	[illegible]	+48	+46	+44	+41	+38	+65
66	66	64	63	61	59	58	56	54	52	50	47	45	53	40	66
67	67	65	64	62	60	59	57	55	53	51	49	46	44	41	67
68	68	66	65	63	62	60	58	56	54	52	50	48	45	43	68
69	69	68	66	64	63	61	59	57	55	53	51	49	47	44	69
+70	+70	+69	+67	+65	+64	+62	+60	+58	+56	+55	+53	+50	+48	+46	+70
71	71	70	68	66	65	63	61	60	58	56	54	52	50	47	71
72	72	71	69	67	66	64	62	61	59	57	55	53	51	49	72
73	73	72	70	68	67	65	64	62	60	58	56	54	52	50	73
74	74	73	71	70	68	66	65	63	61	59	58	56	54	51	74
+75	+75	+74	+72	+71	+69	+67	+66	+64	+62	+61	+59	+57	+55	+53	+75
76	76	75	73	72	70	69	67	65	64	62	60	58	56	54	76
77	77	76	74	73	71	70	68	66	65	63	61	59	57	55	77
78	78	77	75	74	72	71	69	68	66	64	62	60	58	57	78
79	79	78	76	75	73	72	70	69	67	65	64	62	60	58	79
+80	+80	+79	+77	+76	+74	+73	+71	+70	+68	+66	+65	+63	+61	+59	+80
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE II.

Air temp.	Depres						
t	13	14	15	16	17	18	1

t	10	11	1
+32	−16		
34	− 7	−22	
36	− 1	−11	
38	+ 5	− 3	−
40		+ 4	−
42			+

t	10	11

Baro

t	10	11
+32	−12	
34	− 5	−17
36	+ 2	− 7
38	+ 7	0
40		+ 6
42		
44		
46		
48		
50		
+52		

t	10	11

Air temp. t	13	14	15	16	17	18
+30						
31						
32						
33						
34						
+35						
36						
37						
38						
39						
+40	−23					
41	−16					
42	−11	−29				
43	− 6	−20				
44	− 2	−13				
+45	−10	− 8	−24			
46	− 5	−20	−16			
47	0	−13				
48	+ 3	− 7	−28			
49	6	− 3	−18			
+50	+ 9	+ 1	−11			
51	12	5	− 5	−22		
52	14	8	0	−14		
53	17	11	+ 4	− 7	−27	
54	19	14	7	− 2	−17	
+55	+21	+16	+10	+ [illegible]	−10	
56	23	19	13	6	− 4	−20
57	25	21	16	10	+ 1	−12
58	27	23	18	13	5	− 5
59	28	24	20	15	9	0
+60	+30	+26	+22	+18	+12	+ 4
61	32	28	24	20	15	8
62	33	30	26	22	18	12
63	35	32	28	24	20	15
64	37	34	30	26	22	17
+65	+38	+35	+32	+28	+24	+20
66	40	37	34	30	27	22
67	41	38	36	32	28	24
68	43	40	37	34	30	27
69	44	42	39	36	32	29
+70	+46	+43	+40	+38	+34	+31
71	47	45	42	39	36	33
72	49	46	44	41	38	35
73	50	48	45	42	40	36
74	51	49	47	44	41	38
+75	+53	+50	+48	+46	+43	+40
76	54	52	50	47	45	42
77	55	53	51	49	46	43
78	57	54	52	50	48	45
79	58	56	54	52	49	47
+80	+59	+57	+55	+53	+51	+48
	13	14	15	16	17	18

TABLE II. DEW-POINT.

Barometric pressure, 27.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
+ 80	+ 80	+ 79	+ 77	+ 76	+ 74	+73	+ 71	+ 70	+ 68	+66	+65	+63	+ 61	+59	+ 80
81	81	80	78	77	75	74	72	71	69	68	66	64	62	60	81
82	82	81	79	78	76	75	73	72	70	69	67	65	64	62	82
83	83	82	80	79	77	76	74	73	71	70	68	66	65	63	83
84	84	83	81	80	78	77	76	74	72	71	69	68	66	64	84
+ 85	+ 85	+ 84	+ 82	+ 81	+ 80	+78	+ 77	+ 75	+ 74	+72	+70	+69	+ 67	+65	+ 85
86	86	85	83	82	81	79	78	76	75	73	72	70	68	67	86
87	87	86	84	83	82	80	79	77	76	74	73	71	69	68	87
88	88	87	85	84	83	81	80	78	77	75	74	72	71	69	88
89	89	88	86	85	84	82	81	79	78	76	75	73	72	70	89
+ 90	+ 90	+ 89	+ 87	+ 86	+ 85	+83	+ 82	+ 80	+ 79	+78	+76	+74	+ 73	+71	+ 90
91	91	90	88	87	86	84	83	82	80	79	77	76	74	72	91
92	92	91	89	88	87	85	84	83	81	80	78	77	75	74	92
93	93	92	90	89	88	86	85	84	82	81	79	78	76	75	93
94	94	93	91	90	89	88	86	85	83	82	80	79	78	76	94
+ 95	+ 95	+ 94	+ 92	+ 91	+ 90	+89	+ 87	+ 86	+ 84	+83	+82	+80	+ 79	+77	+ 95
96	96	95	94	92	91	90	88	87	86	84	83	81	80	78	96
97	97	96	95	93	92	91	89	88	87	85	84	82	81	79	97
98	98	97	96	94	93	92	90	89	88	86	85	84	82	80	98
99	99	98	97	95	94	93	91	90	89	87	86	85	83	82	99
+100	+100	+ 99	+ 98	+ 96	+ 95	+94	+ 92	+ 91	+ 90	+88	+87	+86	+ 84	+83	+100
101	101	100	99	97	96	95	93	92	91	90	88	87	85	84	101
102	102	101	100	98	97	96	94	93	92	91	89	88	86	85	102
103	103	102	101	99	98	97	96	94	93	92	90	89	88	86	103
104	104	103	102	100	99	98	97	95	94	93	91	90	89	87	104
+105		+104	+103	+101	+100	+99	+ 98	+ 96	+ 95	+94	+92	+91	+ 90	+88	+105
106			104	102	101	100	99	97	96	95	94	92	91	89	106
107				103	102	101	100	98	97	96	95	93	92	90	107
108					103	102	101	99	98	97	96	94	93	92	108
109						103	102	100	99	98	97	95	94	93	109
+110							+103	+102	+100	+99	+98	+96	+ 95	+94	+110
111								103	101	100	99	98	96	95	111
112									102	101	100	99	97	96	112
113										102	101	100	98	97	113
114											102	101	99	98	114
+115												+102	+100	+99	+115
116													102	100	116
117														101	117
118															118
119															119
+120															+120
121															121
122															122
123															123
124															124
+125															+125
126															126
127															127
128															128
129															129
+130															+130
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE II. DEW-POINT.

Barometric pressure, 27.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t-t′).														Air temp.
t	13	14	15	16	17	18	19	20	21	22	23	24	25	26	t
+ 80	+ 59	+ 57	+ 55	+ 53	+ 51	+ 48	+ 46	+ 43	+ 40	+37	+33	+29	+24	+19	+80
81	60	58	56	54	52	50	47	44	42	38	35	31	27	22	81
82	62	60	58	56	53	51	49	46	43	40	37	34	29	25	82
83	63	61	59	57	55	53	50	48	45	42	39	36	32	28	83
84	64	62	60	58	56	54	52	49	47	44	41	38	34	30	84
+ 85	+ 65	+ 64	+ 62	+ 60	+ 58	+ 56	+ 53	+ 51	+ 48	+46	+43	+40	+36	+32	+85
86	67	65	63	61	59	57	55	52	50	47	45	42	38	35	86
87	68	66	64	62	60	58	56	54	52	49	46	44	40	37	87
88	69	67	65	64	62	60	58	55	53	51	48	45	42	39	88
89	70	68	67	65	63	61	59	57	55	52	50	47	44	41	89
+ 90	+ 71	+ 70	+ 68	+ 66	+ 64	+ 62	+ 60	+ 58	+ 56	+54	+52	+49	+46	+43	+90
91	72	71	69	67	66	64	62	60	58	55	53	51	48	45	91
92	74	72	70	69	67	65	63	61	59	57	55	52	50	47	92
93	75	73	72	70	68	66	64	62	60	58	56	54	51	49	93
94	76	74	73	71	69	68	66	64	62	60	58	55	53	50	94
+ 95	+ 77	+ 76	+ 74	+ 72	+ 71	+ 69	+ 67	+ 65	+ 63	+61	+59	+57	+55	+52	+ 95
96	78	77	75	74	72	70	68	66	65	63	61	58	56	54	96
97	79	78	76	75	73	71	70	68	66	64	62	60	58	55	97
98	80	79	78	76	74	73	71	69	67	65	64	61	59	57	98
99	82	80	79	77	76	74	72	70	69	67	65	63	61	58	99
+100	+ 83	+ 81	+ 80	+ 78	+ 77	+ 75	+ 73	+ 72	+ 70	+68	+66	+64	+62	+60	+100
101	84	82	81	79	78	76	75	73	71	69	68	66	64	62	101
102	85	84	82	81	79	78	76	74	72	71	69	67	65	63	102
103	86	85	83	82	80	79	77	75	74	72	70	68	66	64	103
104	87	86	84	83	81	80	78	77	75	73	72	70	68	66	104
+105	+ 88	+ 87	+ 86	+ 84	+ 82	+ 81	+ 80	+ 78	+ 76	+75	+73	+71	+69	+67	+105
106	89	88	87	85	84	82	81	79	78	76	74	72	71	69	106
107	90	89	88	86	85	83	82	80	79	77	75	74	72	70	107
108	92	90	89	87	86	84	83	82	80	78	77	75	73	71	108
109	93	91	90	89	87	86	84	83	81	80	78	76	74	73	109
+110	+ 94	+ 92	+ 91	+ 90	+ 88	+ 87	+ 85	+ 84	+ 82	+81	+79	+78	+76	+74	+110
111	95	94	92	91	89	88	86	85	84	82	80	79	77	75	111
112	96	95	93	92	90	89	88	86	85	83	82	80	78	77	112
113	97	96	94	93	92	90	89	87	86	84	83	81	80	78	113
114	98	97	96	94	93	91	90	88	87	86	84	82	81	79	114
+115	+ 99	+ 98	+ 97	+ 95	+ 94	+ 92	+ 91	+ 90	+ 88	+87	+85	+84	+82	+80	+115
116	100	99	98	96	95	94	92	91	89	88	86	85	83	82	116
117	101	100	99	97	96	95	93	92	90	89	88	86	85	83	117
118		101	100	98	97	96	94	93	92	90	89	87	86	84	118
119			101	100	98	97	96	94	93	91	90	88	87	86	119
+120				+101	+ 99	+ 98	+ 97	+ 95	+ 94	+93	+91	+90	+88	+87	+120
121					100	99	98	96	95	94	92	91	89	88	121
122						100	99	98	96	95	94	92	91	89	122
123							100	99	97	96	95	93	92	90	123
124								100	98	97	96	94	93	92	124
+125									+100	+98	+97	+96	+94	+93	+125
126										99	98	97	95	94	126
127											99	98	96	95	127
128												99	98	96	128
129													99	97	129
+130														+98	+130
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	

TABLE II. DEW-POINT.

Barometric pressure, 27.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	26	27	28	29	30	31	32	33	34	35	36	37	38	39	t
+ 80	+19	+11	+ 1	—16											+ 80
81	22	15	7	— 5											81
82	25	19	12	+ 2	—15										82
83	28	22	16	8	— 4	—30									83
84	30	25	20	13	+ 3	—13									84
+ 85	+32	+28	+23	+17	+ 9	— 2	—26								+ 85
86	35	30	26	21	14	+ 5	—10								86
87	37	33	29	24	18	10	— 1	—23							87
88	39	35	31	27	22	15	+ 6	— 8							88
89	41	38	34	30	25	19	12	+ 1	—19						89
+ 90	+43	+40	+36	+32	+28	+23	+16	+ 8	— 6						+ 90
91	45	42	39	35	30	26	20	13	+ 3	—15					91
92	47	44	41	37	33	29	24	18	10	— 3	—32				92
93	49	46	43	39	36	31	27	21	15	+ 5	—11				93
94	50	48	45	42	38	34	30	25	19	11	0	—24			94
+ 95	+52	+50	+47	+44	+40	+37	+32	+28	+22	+16	+ 7	— 8			+ 95
96	54	51	49	46	42	39	35	31	26	20	13	+ 2	—18		96
97	55	53	50	48	45	41	38	34	29	24	18	9	— 4		97
98	57	55	52	50	47	44	40	36	32	27	22	15	+ 4	—13	98
99	58	56	54	51	48	46	42	39	35	30	25	19	11	— 1	99
+100	+60	+58	+56	+53	+50	+48	+44	+41	+37	+33	+28	+23	+16	+ 7	+100
101	62	60	57	55	52	50	46	43	40	36	32	26	21	13	101
102	63	61	59	56	54	51	48	45	42	38	34	30	24	18	102
103	64	63	60	58	56	53	50	48	44	41	37	33	28	22	103
104	66	64	62	60	57	55	52	50	46	43	40	36	31	26	104
+105	+67	+66	+63	+61	+59	+57	+54	+52	+49	+46	+42	+38	+34	+29	+105
106	69	67	65	63	61	58	56	53	51	48	44	41	37	33	106
107	70	68	66	64	62	60	58	55	52	50	47	43	40	36	107
108	71	70	68	66	64	62	59	57	54	52	49	46	42	38	108
109	73	71	69	67	65	63	61	59	56	54	51	48	44	41	109
+110	+74	+72	+71	+69	+67	+65	+63	+60	+58	+55	+53	+50	+47	+43	+110
111	75	74	72	70	68	66	64	62	60	57	55	52	49	46	111
112	77	75	73	72	70	68	66	64	61	59	56	54	51	48	112
113	78	76	75	73	71	69	67	65	63	61	58	56	53	50	113
114	79	78	76	74	72	71	69	67	64	62	60	58	55	52	114
+115	+80	+79	+77	+76	+74	+72	+70	+68	+66	+64	+62	+59	+57	+54	+115
116	82	80	79	77	75	74	72	70	68	66	63	61	59	56	116
117	83	82	80	78	77	75	73	71	69	67	65	63	60	58	117
118	84	83	81	80	78	76	74	73	71	69	67	64	62	60	118
119	86	84	83	81	79	78	76	74	72	70	68	66	64	62	119
+120	+87	+85	+84	+82	+81	+79	77	+75	+74	+72	+70	+68	+66	+63	+120
121	88	87	85	84	82	80	79	77	75	73	71	69	67	65	121
122	89	88	86	85	83	82	80	78	76	74	73	71	69	67	122
123	90	89	88	86	84	83	81	80	78	76	74	72	70	68	123
124	92	90	89	87	86	84	82	81	79	77	76	74	72	70	124
+125	+93	+92	+90	+88	+87	+85	+84	+82	+80	+79	+77	+75	+73	+71	+125
126	94	93	91	90	88	87	85	84	82	80	78	77	75	73	126
127	95	94	92	91	89	88	86	85	83	82	80	78	76	74	127
128	96	95	94	92	91	89	88	86	84	83	81	79	78	76	128
129	97	96	95	93	92	90	89	87	86	84	82	81	79	77	129
+130	+98	+97	+96	+94	+93	+92	+90	+89	+87	+85	+84	+82	+80	+79	+130
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	

TABLE III. DEW-POINT.

Barometric pressure, 24.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t-t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
							Barometric pressure, 23.0 inches.								
							t	5	6	7					
							+10	−24							
							11	21							
							12	18							
−20	−20						13	15							− 20
19	19						14	−13	−25						19
18	18	−31					15		22						18
17	17	29					16		18						17
−16	−16	−28					17		15						− 16
							18		12	−26					
−15	−15	−26					19		10	21	8	9	10	t	− 15
14	14	25					+20		− 7	17					14
13	13	24								13				+21	13
12	12	22					t	5	6	11	−22			22	12
−11	−11	−21								− 8	18			23	− 11
											14			24	
−10	−10	−20									11	−23		25	− 10
9	9	18									− 7	18		26	9
8	8	16	−29									14		27	8
7	7	15	27									10	−24	28	7
− 6	− 6	−14	−26									7	18	29	− 6
												− 4	−13	30	
− 5	− 5	−13	−23												− 5
4	4	11	21							7	8	9	10	t	4
3	3	10	19												3
2	2	9	17												2
− 1	− 1	− 7	−16	−29			Barometric pressure, 22.0 inches.								− 1
0	0	− 6	−14	−26			t	5	6	7					0
+ 1	+ 1	5	12	24											+ 1
2	2	4	11	21			+10	−22							2
3	3	2	9	19			11	19							3
4	4	− 1	− 8	−17	−31		12	16							4
							13	13							
+ 5	+ 5	0	− 6	−15	−28		14	−11	−22						+ 5
6	6	+ 1	5	13	25		15		18						6
7	7	2	3	11	22		16		16						7
8	8	3	2	9	19		17		12						8
9	9	5	− 1	− 7	−16		18		10	−22					9
							19		8	17	8	9	10	t	
+10	+10	+ 6	+ 1	− 6	−14	−27	+20		− 5	14					+ 10
11	11	7	2	4	12	24				11				+21	11
12	12	8	4	3	10	20	t	5	6	8	−19			22	12
13	13	9	5	− 1	8	17				− 6	14			23	13
14	14	10	6	0	− 6	−15	−29				12			24	14
											8	−19		25	
+15	+15	+12	+ 7	+ 2	− 4	−12	−25				− 5	15		26	+ 15
16	16	13	8	4	− 2	10	21					11		27	16
17	17	14	10	5	0	7	17					8	−18	28	17
18	18	15	11	7	+ 2	5	14	−31				5	14	29	18
19	19	16	12	8	3	− 3	−12	24				− 2	−10	+30	19
+20	+20	+17	+14	+10	+ 5	− 1	− 9	−20		7	8	9	10	t	+ 20
21	21	16	15	11	7	+ 1	6	16							21
22	22	19	16	12	8	3	3	13	−26						22
23	23	20	17	14	10	5	− 1	10	21						23
24	24	21	18	15	11	6	+ 1	− 6	−17						24
+25	+25	+22	+19	+16	+13	+ 8	+ 3	− 4	−13	−28					+ 25
26	26	23	21	18	14	10	5	− 1	9	22					26
27	27	24	22	19	16	12	7	+ 1	6	17					27
28	28	26	23	20	17	13	9	3	3	13	−29				28
29	29	27	24	21	18	15	10	5	− 1	−10	−22				29
+30	+30	+28	+25	+22	+19	+16	+12	+ 7	+ 2	− 6	−17				+ 30
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE III. DEW-POINT.

Barometric pressure, 24.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t-t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
+30	+30	+28	+25	+22	+19	+16	+12	+ 7	+ 2	− 6	−17				+30
31	31	29	26	24	21	17	14	9	4	− 3	12	−29			31
32	32	30	27	25	22	19	15	11	6	0	8	22			32
33	33	31	28	26	23	20	17	13	8	+ 2	5	16			33
34	34	32	29	27	24	22	18	15	10	5	− 2	−11	−27		34
+35	+35	+33	+30	+27	+26	+23	+20	+16	+12	+ 7	+ 1	− 7	−20		+35
36	36	34	31	28	26	24	21	18	14	9	4	− 4	14		36
37	37	35	32	30	27	24	22	19	16	11	6	0	10	−25	37
38	38	36	33	31	28	25	22	20	17	13	8	+ 2	6	18	38
39	39	37	34	32	29	26	23	20	19	15	10	5	− 2	−12	39
+40	+40	+38	+36	+33	+30	+28	+25	+21	+18	17	+13	+ 8	+1	− 8	+40
41	41	39	37	34	32	29	26	23	19	15	15	10	4	− 4	41
42	42	40	38	35	33	30	27	24	20	17	12	12	7	0	42
43	43	41	39	36	34	31	29	26	22	19	14	9	9	+ 3	43
44	44	42	40	38	35	33	30	27	24	20	16	11	5	6	44
+45	+45	+43	+41	+39	+36	+34	+31	+28	+25	+22	+18	+14	+ 8	0	+45
46	46	44	42	40	38	35	32	30	27	23	20	16	10	+ 4	46
47	47	45	43	41	39	36	34	31	28	25	21	18	13	7	47
48	48	46	44	42	40	38	35	32	29	26	23	19	15	9	48
49	49	47	45	43	31	39	36	34	31	28	25	21	17	12	49
+50	+50	+48	+46	+44	+42	+40	+37	+35	+32	+29	+26	+23	+19	+14	+50
51	51	49	47	45	43	41	39	36	34	31	28	24	21	16	51
52	52	50	48	46	44	42	40	38	35	32	29	26	23	18	52
53	53	51	49	48	46	43	41	39	36	34	31	28	24	20	53
54	54	52	50	49	47	45	42	40	38	35	32	29	26	22	54
+55	+55	+53	+52	+50	+48	+46	+44	+41	+39	+36	+34	+31	+28	+24	+55
56	56	54	53	51	49	47	45	42	40	38	35	32	29	26	56
57	57	55	54	52	50	48	46	44	42	39	36	34	31	28	57
58	58	56	55	53	51	49	47	45	43	40	38	35	32	29	58
59	59	57	56	54	52	50	48	46	44	42	39	37	34	31	59
+60	+60	+58	+57	+55	+53	+51	+49	+47	+45	+43	+41	+38	+35	+32	+60
61	61	59	58	56	54	52	51	49	46	44	42	40	37	34	61
62	62	60	59	57	55	54	52	50	48	46	43	41	39	36	62
63	63	61	60	58	56	55	53	51	49	47	45	42	40	37	63
64	64	62	61	59	58	56	54	52	50	48	46	44	41	38	64
+65	+65	+64	+62	+60	+59	+57	+55	+53	+51	+49	+47	+45	+43	+40	+65
66	66	65	63	61	60	58	56	54	52	51	48	46	44	42	66
67	67	66	64	62	61	59	57	56	54	52	50	48	45	43	67
68	68	67	65	63	62	60	58	57	55	53	51	49	47	44	68
69	69	68	66	64	63	61	60	58	56	54	52	50	48	46	69
+70	+70	+69	+67	+66	+64	+62	+61	+59	+57	+55	+54	+52	+49	+47	+70
71	71	70	68	67	65	63	62	60	58	57	55	53	51	49	71
72	72	71	69	68	66	64	63	61	60	58	56	54	52	50	72
73	73	72	70	69	67	66	64	62	61	69	57	55	53	51	73
74	74	73	71	70	68	67	65	64	62	60	58	56	54	52	74
+75	+75	+74	+72	+71	+69	+68	+66	+65	+63	+61	+59	+58	+56	+54	+75
76	76	75	73	72	70	69	67	66	64	62	61	59	57	55	76
77	77	76	74	73	71	70	68	67	65	64	62	60	58	56	77
48	78	77	75	74	72	71	69	68	66	65	63	61	59	58	78
79	79	78	76	75	73	72	70	69	67	66	64	62	61	59	79
+80	+80	+79	+77	+76	+74	+73	+72	+70	+68	+67	+65	+64	+62	+60	+80
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

Table III.

Air temp.							Depr
t	13	14	15	16	17	18	1
						t	10
						+30	−13
						32	− 6
						34	0
						36	−
						38	+
+30						40	
31						42	
32						44	
33						46	
34						48	
						+50	
+35						t	10
36							
37	−25						
38	18						
39	−12	−31					
						t	10
+40	− 8	−22					
41	− 4	15				+30	−10
42	0	10	−25			32	− 3
43	+ 3	6	18			34	+ 2
44	6	− 2	−12	−29		36	+
						38	+
+45	0	+ 2	− 7	−20		40	
46	+ 4	− 6	2	13		42	
47	7	− 1	13	8	−22	44	
48	9	+ 2	8	24	−14	46	
49	12	5	− 3	−16		48	
						+50	
+50	+14	+ 8	+ 1	− 9	−28	t	10
51	16	11	4	− 4	18		
52	18	14	8	0	11		
53	20	16	10	+ 4	6	−21	
54	22	18	13	7	− 1	−13	
+55	+24	+20	+16	+10	+ 3	− 7	−24
56	26	22	18	13	7	− 2	15
57	28	24	20	16	10	+ 3	8
58	29	26	22	18	13	6	− 2
59	31	27	24	20	15	10	+ 2
+60	+32	+29	+26	+22	18	+13	+ 6
61	34	31	28	24	20	15	9
62	36	32	29	26	22	18	12
63	37	34	31	28	24	20	15
64	38	36	33	30	26	22	18
+65	+40	+37	+34	+31	+28	+24	+20
66	42	39	36	33	30	26	23
67	43	40	38	35	32	28	25
68	44	42	39	37	34	30	27
69	46	43	41	38	35	32	29
+70	+47	+45	+42	+40	+37	+34	+31
71	49	46	44	41	39	36	33
72	50	48	45	43	40	38	34
73	51	49	47	44	42	39	36
74	52	50	48	46	44	41	38
+75	+54	+52	+50	+47	+45	+42	+40
76	55	53	51	49	46	44	41
77	56	54	52	50	48	46	43
78	58	56	54	52	49	47	45
79	59	57	55	53	51	49	46
+80	+60	+58	+56	+54	+52	+50	+48
	13	14	15	16	17	18	19

TABLE III. DEW-POINT.

Barometric pressure, 24.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t-t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
+30	+30	+28	+25	+22	+19	+16	+12	+ 7	+ 2	− 6	−17				+30
31	31	29	26	24	21	17	14	9	4	− 3	12	−29			31
32	32	30	27	25	22	19	15	11	6	0	8	22			32
33	33	31	28	26	23	20	17	13	8	+ 2	5	16			33
34	34	32	29	27	24	22	18	15	10	5	− 2	−11	−27		34
+35	+35	+33	+30	+27	+26	+23	+20	+16	+12	+ 7	+ 1	− 7	−20		+ 35
36	36	34	31	28	26	24	21	18	14	9	4	− 4	14		36
37	37	35	32	30	27	24	22	19	16	11	6	0	10	−25	37
38	38	36	33	31	28	25	22	20	17	13	8	+ 2	6	18	38
39	39	37	34	32	29	26	23	20	19	15	10	5	− 2	−12	39
+40	+40	+38	+36	+33	+30	+28	+25	+21	+18	17	+13	+ 8	+1	− 8	+40
41	41	39	37	34	32	29	26	23	19	15	15	10	4	− 4	41
42	42	40	38	35	33	30	27	24	20	17	12	12	7	0	42
43	43	41	39	36	34	31	29	26	22	19	14	9	9	+ 3	43
44	44	42	40	38	35	33	30	27	24	20	16	11	5	6	44
+45	+45	+43	+41	+39	+36	+34	+31	+28	+25	+22	+18	+14	+ 8	0	+45
46	46	44	42	40	38	35	32	30	27	23	20	16	10	+ 4	46
47	47	45	43	41	39	36	34	31	28	25	21	18	13	7	47
48	48	46	44	42	40	38	35	32	29	26	23	19	15	9	48
49	49	47	45	43	31	39	36	34	31	28	25	21	17	12	49
+50	+50	+48	+46	+44	+42	+40	+37	+35	+32	+29	+26	+23	+19	+14	+50
51	51	49	47	45	43	41	39	36	34	31	28	24	21	16	51
52	52	50	48	46	44	42	40	38	35	32	29	26	23	18	52
53	53	51	49	48	46	43	41	39	36	34	31	28	24	20	53
54	54	52	50	49	47	45	42	40	38	35	32	29	26	22	54
+55	+55	+53	+52	+50	+48	+46	+44	+41	+39	+36	+34	+31	+28	+24	+55
56	56	54	53	51	49	47	45	42	40	38	35	32	29	26	56
57	57	55	54	52	50	48	46	44	42	39	36	34	31	28	57
58	58	56	55	53	51	49	47	45	43	40	38	35	32	29	58
59	59	57	56	54	52	50	48	46	44	42	39	37	34	31	59
+60	+60	+58	+57	+55	+53	+51	+49	+47	+45	+43	+41	+38	+35	+32	+60
61	61	59	58	56	54	52	51	49	46	44	42	40	37	34	61
62	62	60	59	57	55	54	52	50	48	46	43	41	39	36	62
63	63	61	60	58	56	55	53	51	49	47	45	42	40	37	63
64	64	62	61	59	58	56	54	52	50	48	46	44	41	38	64
+65	+65	+64	+62	+60	+59	+57	+55	+53	+51	+49	+47	+45	+43	+40	+65
66	66	65	63	61	60	58	56	54	52	51	48	46	44	42	66
67	67	66	64	62	61	59	57	56	54	52	50	48	45	43	67
68	68	67	65	63	62	60	58	57	55	53	51	49	47	44	68
69	69	68	66	64	63	61	60	58	56	54	52	50	48	46	69
+70	+70	+69	+67	+66	+64	+62	+61	+59	+57	+55	+54	+52	+49	+47	+70
71	71	70	68	67	65	63	62	60	58	57	55	53	51	49	71
72	72	71	69	68	66	64	63	61	60	58	56	54	52	50	72
73	73	72	70	69	67	66	64	62	61	69	57	55	53	51	73
74	74	73	71	70	68	67	65	64	62	60	58	56	54	52	74
+75	+75	+74	+72	+71	+69	+68	+66	+65	+63	+61	+59	+58	+56	+54	+75
76	76	75	73	72	70	69	67	66	64	62	61	59	57	55	76
77	77	76	74	73	71	70	68	67	65	64	62	60	58	56	77
48	78	77	75	74	72	71	69	68	66	65	63	61	59	58	78
79	79	78	76	75	73	72	70	69	67	66	64	62	61	59	79
+80	+80	+79	+77	+76	+74	+73	+72	+70	+68	+67	+65	+64	+62	+60	+80
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE III.

Air temp.							Depr
t	13	14	15	16	17	18	1
						t	10
						+30	−13
						32	− 6
						34	0
						36	
						38	
+30						40	
31						42	
32						44	
33						46	
34						48	
						+50	
+35							
36						t	10
37	−25						
38	18						
39	−12	−31					
						t	10
+40	− 8	−22					
41	− 4	15				+30	−10
42	0	10	−25			32	− 3
43	+ 3	6	18			34	+ 2
44	6	− 2	−12	−29		36	
						38	
+45	0	+ 2	− 7	−20		40	
46	+ 4	− 6	2	13		42	
47	7	− 1	13	8	−22	44	
48	9	+ 2	8	24	−14	46	
49	12	5	− 3	−16		48	
						+50	
+50	+14	+ 8	+ 1	− 9	−28		
51	16	11	4	− 4	18	t	10
52	18	14	8	0	11		
53	20	16	10	+ 4	6	−21	
54	22	18	13	7	− 1	−13	
+55	+24	+20	+16	+10	+ 3	− 7	−24
56	26	22	18	13	7	− 2	15
57	28	24	20	16	10	+ 3	8
58	29	26	22	18	13	6	− 2
59	31	27	24	20	15	10	+ 2
+60	+32	+29	+26	+22	18	+13	+ 6
61	34	31	28	24	20	15	9
62	36	32	29	26	22	18	12
63	37	34	31	28	24	20	15
64	38	36	33	30	26	22	18
+65	+40	+37	+34	+31	+28	+24	+20
66	42	39	36	33	30	26	23
67	43	40	38	35	32	28	25
68	44	42	39	37	34	30	27
69	46	43	41	38	35	32	29
+70	+47	+45	+42	+40	+37	+34	+31
71	49	46	44	41	39	36	33
72	50	48	45	43	40	38	34
73	51	49	47	44	42	39	36
74	52	50	48	46	44	41	38
+75	+54	+52	+50	+47	+45	+42	+40
76	55	53	51	49	46	44	41
77	56	54	52	50	48	46	43
78	58	56	54	52	49	47	45
79	59	57	55	53	51	49	46
+80	+60	+58	+56	+54	+52	+50	+48
	13	14	15	16	17	18	19

3 v o

TABLE I. DEW-POINT.

Barometric pressure, 30.0 *inches.*

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
+ 80	+ 80	+ 79	+ 77	+ 76	+ 74	+ 73	+ 72	+ 70	+ 68	+ 67	+ 65	+ 64	+ 62	+ 60	+ 80
81	81	80	78	77	76	74	73	71	70	68	66	65	63	61	81
82	82	81	79	78	77	75	74	72	71	69	68	66	64	62	82
83	83	82	80	79	78	76	75	73	72	70	69	67	75	64	83
84	84	83	81	80	79	77	76	74	73	71	70	68	67	65	84
+ 85	+ 85	+ 84	+ 82	+ 81	+ 80	+ 78	+ 77	+ 75	+ 74	+ 72	+ 71	+ 69	+ 68	+ 66	+ 85
86	86	85	83	82	81	79	78	77	75	74	72	70	69	67	86
87	87	86	84	83	82	80	79	78	76	75	73	72	70	68	87
88	88	87	85	84	83	81	80	79	77	76	74	73	71	70	88
89	89	88	86	85	84	82	81	80	78	77	75	74	72	71	89
+ 90	+ 90	+ 89	+ 87	+ 86	+ 85	+ 84	+ 82	+ 81	+ 79	+ 78	+ 76	+ 75	+ 74	+ 72	+ 90
91	91	90	88	87	86	85	83	82	80	79	78	76	75	73	91
92	92	91	89	88	87	86	84	83	82	80	79	77	76	74	92
93	93	92	90	89	88	87	85	84	83	81	80	78	77	75	93
94	94	93	91	90	89	88	86	85	84	82	81	80	78	76	94
+ 95	+ 95	+ 94	+ 92	+ 91	+ 90	+ 89	+ 87	+ 86	+ 85	+ 83	+ 82	+ 81	+ 79	+ 78	+ 95
96	96	95	94	92	91	90	88	87	86	84	83	82	80	79	96
97	97	96	95	93	92	91	89	88	87	86	84	83	81	80	97
98	98	97	96	94	93	92	90	89	88	87	85	84	82	81	98
99	99	98	97	95	94	93	92	90	89	88	86	85	84	82	99
+100	+100	+ 99	+ 98	+ 96	+ 95	+ 94	+ 93	+ 91	+ 90	+ 89	+ 87	+ 86	+ 85	+ 83	+100
101	101	100	99	97	96	95	94	92	91	90	88	87	86	84	101
102	102	101	100	98	97	96	95	93	92	91	90	88	87	85	102
103	103	102	101	99	98	97	96	94	93	92	91	89	88	86	103
104	104	103	102	100	99	98	97	96	94	93	92	90	89	88	104
+105		+104	+103	+101	+100	+ 99	+ 98	+ 97	+ 95	+ 94	+ 93	+ 91	+ 90	+ 89	+105
106			104	102	101	100	99	98	96	95	94	92	91	90	106
107				104	102	101	100	99	97	96	95	94	92	91	107
108					103	102	101	100	98	97	96	95	93	92	108
109						103	102	101	99	98	97	96	94	93	109
+110							+103	+102	+100	+ 99	+ 98	+ 97	+ 95	+ 94	+110
111								103	102	100	99	98	96	95	111
112									103	101	100	99	98	96	112
113										102	101	100	99	97	113
114											102	101	100	98	114
+115												+102	+101	+100	+115
116													102	101	116
117														102	117
118															118
119															119
+120															+120
121															121
122															122
123															123
124															124
+125															+125
126															126
127															127
128															128
129															129
+130															+130
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE III. DEW-POINT.

Barometric pressure, 24.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	13	14	15	16	17	18	19	20	21	22	23	24	25	26	t
+80	+60	+58	+56	+54	+52	+50	+48	+45	+43	+40	+37	+33	+30	+26	+80
81	61	59	58	56	54	52	49	47	44	42	39	36	32	28	81
82	62	61	59	57	55	53	51	48	46	43	40	37	34	30	82
83	64	62	60	58	56	54	52	50	48	45	42	39	36	33	83
84	65	63	61	60	58	56	54	51	49	47	44	41	38	35	84
+85	+66	+64	+63	+61	+59	+57	+55	+53	+51	+48	+46	+43	+40	+37	+85
86	67	66	64	62	60	58	56	54	52	50	47	45	42	39	86
87	68	67	65	63	62	60	58	56	54	51	49	46	44	41	87
88	70	68	66	65	63	61	59	57	55	53	50	48	46	43	88
89	71	69	68	66	64	62	60	58	56	54	52	50	47	44	89
+90	+72	+70	+69	+67	+65	+64	+62	+60	+58	+56	+54	+51	+49	+46	+90
91	73	72	70	68	67	65	63	61	59	57	55	53	51	48	91
92	74	73	71	70	68	66	64	62	61	59	56	54	52	50	92
93	75	74	72	71	69	67	66	64	62	60	58	56	54	51	93
94	76	75	74	72	70	69	67	65	63	61	59	57	55	53	94
+95	+78	+76	+75	+73	+72	+70	+68	+66	+65	+63	+61	+59	+57	+54	+95
96	79	77	76	74	73	71	69	68	66	64	72	60	58	56	96
97	80	78	77	75	74	72	71	69	67	65	64	62	60	58	97
98	81	80	78	77	75	74	72	70	68	67	65	63	61	59	98
99	82	81	79	78	76	75	73	72	70	68	66	64	62	60	99
+100	+83	+82	+80	+79	+77	+76	+74	+73	+71	+69	+68	+66	+64	+62	+100
101	84	83	82	80	79	77	76	74	72	71	69	67	65	63	101
102	85	84	83	81	80	78	77	75	74	72	70	68	67	65	102
103	86	85	84	82	81	79	78	76	75	73	71	70	68	66	103
104	88	86	85	84	82	81	79	78	76	74	73	71	69	68	104
+105	+89	+87	+86	+85	+83	+82	+80	+79	+77	+76	+74	+72	+71	+69	+105
106	90	88	87	86	84	83	81	80	78	77	75	74	72	70	106
107	91	90	88	87	85	84	83	81	80	78	76	75	73	72	107
108	92	91	89	88	86	85	84	82	81	79	78	76	74	73	108
109	93	92	90	89	88	86	85	83	82	80	79	77	76	74	109
+110	+94	+93	+92	+90	+89	+87	+86	+85	+83	+82	+80	+78	+77	+75	+110
111	95	94	93	91	90	89	87	86	84	83	81	80	78	77	111
112	96	95	94	92	91	90	88	87	85	84	82	81	79	78	112
113	97	96	95	93	92	91	89	88	87	85	84	82	81	79	113
114	98	97	96	94	93	92	90	89	88	86	85	83	82	80	114
+115	+100	+98	+97	+96	+94	+93	+92	+90	+89	+88	+86	+85	+83	+82	+115
116	101	99	98	97	95	94	83	91	90	89	87	86	84	83	116
117	102	100	99	98	96	95	94	93	91	90	88	87	85	84	117
118		101	100	99	98	96	95	94	92	91	90	88	87	85	118
119			101	100	99	97	96	95	93	92	91	89	88	86	119
+120				+101	+100	+98	+97	+96	+94	+93	+92	+90	+89	+88	+120
121					101	100	98	97	96	94	93	92	90	89	121
122						101	99	98	97	95	94	93	91	90	122
123							100	99	98	97	95	94	92	91	123
124								100	99	98	96	95	94	92	124
+125									+100	+99	+98	+96	+95	+93	+125
126										100	99	97	96	94	126
127											100	98	97	96	127
128												100	98	97	128
129													99	98	129
+130														+99	+130
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	

TABLE IV. DEW-POINT.

Barometric pressure, 21.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
−20	−20														−20
19	19	−31													19
18	18	29													18
17	17	27													17
−16	−16	−26													−16
−15	−15	−24													−15
14	14	23													14
13	13	22													13
12	12	20													12
−11	−11	−19	−30												−11
−10	−10	−18	−28												−10
9	9	16	26												9
8	8	15	24												8
7	7	14	23												7
− 6	− 6	−12	−22												− 6
− 5	− 5	−11	−19												− 5
4	4	10	18	−30											4
3	3	9	16	27											3
2	2	8	14	25											2
− 1	− 1	− 6	−13	−23											− 1
0	0	− 5	−12	−21											0
+ 1	+ 1	4	10	19											+ 1
2	2	3	8	17	−29										2
3	3	2	7	15	26										3
4	4	− 1	− 6	−13	−23										4
+ 5	+ 5	+ 1	− 4	−11	−21										+ 5
6	6	2	3	10	18										6
7	7	3	2	8	16	−28									7
8	8	4	− 1	6	14	24									8
9	9	5	+ 1	− 5	−12	−22									9
+10	+10	+ 6	+ 2	− 3	−10	−19									+10
11	11	8	4	− 2	8	16	−29								11
12	12	9	5	0	6	14	24								12
13	13	10	6	+ 1	5	11	21								13
14	14	11	7	2	− 3	− 9	−18								14
+15	+15	+12	+ 8	+ 4	− 1	− 7	−15	−29							+15
16	16	13	10	5	0	6	13	24							16
17	17	14	11	7	+ 2	3	10	20							17
18	18	15	12	8	4	− 1	8	17							18
19	19	16	13	10	5	0	− 6	−14	−27						19
+20	+20	+17	+15	+11	+ 7	+ 2	− 3	−11	−22						+20
21	21	18	16	12	8	4	− 1	8	18						21
22	22	19	17	14	10	6	+ 1	6	15	−28					22
23	23	21	18	15	11	8	3	4	11	23					23
24	24	22	19	16	13	9	4	− 1	− 9	−18					24
+25	+25	+23	+20	+17	+14	+10	+ 6	+ 1	− 6	−14	−28				+25
26	26	24	21	18	15	12	8	3	3	11	22				26
27	27	25	22	20	17	14	10	5	− 1	8	17				27
28	28	26	23	21	18	15	11	7	+ 2	5	13	−27			28
29	29	27	24	22	19	16	13	9	4	− 2	−10	−21			29
+30	+30	+28	+26	+23	+20	+18	+14	+10	+ 6	0	− 6	−16			+30
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE IV. **DEW-POINT.**

Barometric pressure, 21.0 inches.

Air emp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
+30	+30	+28	+26	+23	+20	+18	+14	+10	+ 6	0	− 6	−16			+30
31	**31**	29	27	24	22	19	16	12	8	+ 3	4	12	−25		31
32	32	**30**	28	25	23	20	17	14	10	5	− 1	8	19		32
33	33	31	**29**	26	24	21	19	15	11	7	+ 2	5	14	−30	33
34	34	32	29	**28**	25	23	20	17	13	9	4	−2	−10	−22	34
+35	+35	+33	+30	+28	**+26**	+24	+21	+18	+15	+11	+ 6	+ 1	− 6	−17	+35
36	36	34	32	29	26	**25**	23	20	16	13	8	4	− 3	12	36
37	37	35	33	30	28	25	**24**	21	18	15	10	6	0	8	37
38	38	36	34	31	29	26	24	**23**	19	16	12	8	+ 3	4	38
39	39	37	35	32	30	28	25	22	**21**	18	14	10	5	− 1	39
+40	+40	+38	+36	+34	+31	+29	+26	+23	+20	**+19**	+16	+12	+ 8	+ 2	+40
41	41	39	37	35	32	30	27	24	21	18	**18**	14	10	5	41
42	42	40	38	36	34	31	28	26	23	19	16	**16**	12	7	42
43	43	41	39	37	35	32	30	27	24	21	17	14	**14**	10	43
44	44	42	40	38	36	34	31	28	26	23	19	15	11	**12**	44
+45	+45	+43	+41	+39	+37	+35	+32	+30	+27	+24	+21	+17	+13	+ 8	+45
46	46	44	42	40	38	36	34	31	28	25	22	19	15	10	46
47	47	45	43	41	39	37	35	32	30	27	24	21	17	12	47
48	48	46	44	42	40	38	36	34	31	28	25	22	19	14	48
49	49	47	45	44	42	39	37	35	32	30	27	24	20	16	49
+50	+50	+48	+46	+45	+43	+41	+38	+36	+34	+31	+28	+25	+22	+18	+50
51	51	49	48	46	44	42	40	37	35	32	30	27	24	20	51
52	52	50	49	47	45	43	41	38	36	34	31	28	25	22	52
53	53	51	50	48	46	44	42	40	37	35	32	30	27	24	53
54	54	52	51	49	47	45	43	41	39	36	34	31	28	25	54
+55	+55	+53	+52	+50	+48	+46	+44	+42	+40	+38	+35	+33	+30	+27	+55
56	56	54	53	51	49	47	46	43	41	39	37	34	31	28	56
57	57	55	54	52	50	48	47	45	42	40	38	36	33	30	57
58	58	56	55	53	51	50	48	46	44	42	39	37	34	32	58
59	59	57	56	54	52	51	49	47	45	43	41	38	36	33	59
+60	+60	+58	+57	+55	+54	+52	+50	+48	+46	+44	+42	+40	+37	+35	+60
61	61	60	58	56	55	53	51	49	47	45	43	41	39	36	61
62	62	61	59	57	56	54	52	50	48	47	44	42	40	38	62
63	63	62	60	58	57	55	53	52	50	48	46	44	42	39	63
64	64	63	61	60	58	56	54	53	51	49	47	45	43	40	64
+65	+65	+64	+62	+61	+59	+57	+56	+54	+52	+50	+48	+46	+44	+42	+65
66	66	65	63	62	60	58	57	55	53	51	50	48	46	43	66
67	67	66	64	63	61	60	58	56	54	53	51	49	47	45	67
68	68	67	65	64	62	61	59	57	56	54	52	50	48	46	68
69	69	68	66	65	63	62	60	58	57	55	53	51	49	47	69
+70	+70	+69	+67	+66	+64	+63	+61	+60	+58	+56	+54	+52	+51	+49	+70
71	71	70	68	67	65	64	62	61	59	57	56	54	52	50	71
72	72	71	69	68	66	65	63	62	60	58	57	55	53	51	72
73	73	72	70	69	67	66	64	63	61	60	58	56	54	52	73
74	74	73	71	70	68	67	65	64	62	61	59	57	56	54	74
+75	+75	+74	+72	+71	+69	+68	+66	+65	+63	+62	+60	+58	+57	+55	+75
76	76	75	73	72	70	69	68	66	64	63	61	60	58	56	76
77	77	76	74	73	72	70	69	67	66	64	62	61	59	57	77
78	78	77	75	74	73	71	70	68	67	65	64	62	60	59	78
79	79	78	76	75	74	72	71	69	68	66	65	63	62	60	79
+80	+80	+79	+77	+76	+75	+73	+72	+70	+69	+67	+66	+64	+63	+61	+80
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE IV. DEW-POINT.

Barometric pressure, 21.0 *inches*.

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	13	14	15	16	17	18	19	20	21	22	23	24	25	26	t
+30															+30
31															31
32															32
33	−30														33
34	−22														34
+35	−17														+35
36	−12	−26													36
37	− 8	−19													37
38	− 4	−14	−29												38
39	− 1	− 9	−21												39
+40	+ 2	− 5	−15												+40
41	5	− 2	−10	−28											41
42	7	+ 1	− 6	−16											42
43	10	4	− 2	−11	−25										43
44	12	7	+ 1	− 6	−18										44
+45	+ 8	+ 9	+ 4	− 3	−12	−27									+45
46	10	4	7	+ 1	− 7	−19									46
47	12	7	0	+ 4	− 3	−13	−30								47
48	14	10	3	− 4	+ 1	− 8	−21								48
49	16	12	6	− 1	−10	− 3	−14								49
+50	+18	+14	+ 9	+ 3	− 6	−19	− 8	−22							+50
51	20	16	12	6	− 1	−12		−15							51
52	22	18	14	9	+ 2	− 7	−22								52
53	24	20	16	11	6	− 2	−14								53
54	25	22	18	14	9	+ 2	− 8	−24							54
+55	+27	+24	+20	+16	+12	+ 5	− 3	−16							+55
56	28	25	22	18	14	9	+ 1	− 9	−27						56
57	30	27	24	20	16	11	5	− 4	−17						57
58	32	29	26	22	18	14	8	+ 1	−10	−28					58
59	33	30	27	24	20	16	11	5	− 4	−18					59
+60	+35	+32	+29	+26	+22	+19	+14	+ 8	+ 1	−10	−30				+60
61	36	33	31	28	24	21	16	11	5	− 4	−18				61
62	38	35	32	29	26	23	19	14	8	+ 1	−10	−31			62
63	39	36	34	31	28	25	21	16	11	5	− 4	−18			63
64	40	38	36	33	30	26	23	19	14	9	+ 1	−10	−31		64
+65	+42	+39	+37	+34	+31	+28	+25	+21	+17	+12	+ 5	− 4	−18		+65
66	43	41	38	36	33	30	27	23	19	15	9	+ 1	−10	−31	66
67	45	42	40	38	35	32	29	25	22	17	12	6	− 4	−18	67
68	46	44	41	39	36	34	30	27	24	20	15	9	+ 2	−10	68
69	47	45	43	41	38	35	32	29	26	22	18	13	6	− 3	69
+70	+49	+46	+44	+42	+40	+37	+34	+31	+28	+24	+20	+16	+10	+ 2	+70
71	50	48	46	44	41	38	36	33	30	26	23	18	13	7	71
72	51	49	47	45	43	40	38	35	32	28	25	21	16	11	72
73	52	50	48	46	44	42	39	36	33	30	27	23	19	14	73
74	54	52	50	48	46	43	41	38	35	32	29	25	21	17	74
+75	+55	+53	+51	+49	+47	+45	+42	+40	+37	+34	+31	+28	+24	+20	+75
76	56	54	52	50	48	46	44	41	39	36	33	30	26	22	76
77	57	56	54	52	50	48	45	43	40	38	35	32	28	24	77
78	59	57	55	53	51	49	47	44	42	39	37	34	30	27	78
79	60	58	56	54	52	50	48	46	44	41	38	36	32	29	79
+80	+61	+59	+58	+56	+54	+52	+50	+47	+45	+43	+40	+37	+34	+31	+80
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	

TABLE IV. DEW-POINT.

Barometric pressure, 21.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
+ 80	+ 80	+ 79	+ 77	+ 76	+ 75	+ 73	+ 72	+ 70	+ 69	+ 67	+ 66	+ 64	+ 63	+ 61	+ 80
81	81	80	78	77	76	74	73	71	70	68	67	65	64	62	81
82	82	81	79	78	77	75	74	73	71	70	68	67	65	63	82
83	83	82	80	79	78	76	75	74	72	71	69	68	66	64	83
84	84	83	82	80	79	77	76	75	73	72	70	69	67	66	84
+ 85	+ 85	+ 84	+ 83	+ 81	+ 80	+ 78	+ 77	+ 76	+ 74	+ 73	+ 72	+ 70	+ 68	+ 67	+ 85
86	86	85	84	82	81	80	78	77	75	74	73	71	70	68	86
87	87	86	85	83	82	81	79	78	76	75	74	72	71	69	87
88	88	87	86	84	83	82	80	79	78	76	75	73	72	70	88
89	89	88	87	85	84	83	81	80	79	77	76	74	73	72	89
+ 90	+ 90	+ 89	+ 88	+ 86	+ 85	+ 84	+ 82	+ 81	+ 80	+ 78	+ 77	+ 76	+ 74	+ 73	+ 90
91	91	90	89	87	86	85	83	82	81	79	78	77	75	74	91
92	92	91	90	88	87	86	84	83	82	80	79	78	76	75	92
93	93	92	91	89	88	87	86	84	83	82	80	79	77	76	93
94	94	93	92	90	89	88	87	85	84	83	81	80	78	77	94
+ 95	+ 95	+ 94	+ 93	+ 91	+ 90	+ 89	+ 88	+ 86	+ 85	+ 84	+ 82	+ 81	+ 80	+ 78	+ 95
96	96	95	94	92	91	90	89	87	86	85	83	82	81	79	96
97	97	96	95	93	92	91	90	88	87	86	84	83	82	80	97
98	98	97	96	94	93	92	91	89	88	87	86	84	83	82	98
99	99	98	97	95	94	93	92	90	89	88	87	85	84	83	99
+100	+100	+ 99	+ 98	+ 96	+ 95	+ 94	+ 93	+ 92	+ 90	+ 89	+ 88	+ 86	+ 85	+ 84	+100
101	101	100	99	97	96	95	94	93	91	90	89	88	86	85	101
102	102	101	100	98	97	96	95	94	92	91	90	89	87	86	102
103	103	102	101	99	98	97	96	95	93	92	91	90	88	87	103
104	104	103	102	100	99	98	97	96	94	93	92	91	89	88	104
+105		+104	+103	+101	+100	+ 99	+ 98	+ 97	+ 96	+ 94	+ 93	+ 92	+ 90	+ 89	+105
106			104	102	101	100	99	98	97	95	94	93	92	90	106
107				103	102	101	100	99	98	96	95	94	93	91	107
108					103	102	101	100	99	97	96	95	94	92	108
109						103	102	101	100	98	97	96	95	93	109
+110							+103	+102	+101	+ 99	+ 98	+ 97	+ 96	+ 94	+110
111								103	102	100	99	98	97	96	111
112									103	102	100	99	98	97	112
113										103	101	100	99	98	113
114											102	101	100	99	114
+115												+102	+101	+100	+115
116													102	101	116
117														102	117
118															118
119															119
+120															+120
121															121
122															122
123															123
124															124
+125															+125
126															126
127															127
128															128
129															129
+130															+130
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE IV. DEW-POINT.

Barometric pressure, 21.0 inches.

Air temp.	Depression of the wet-bulb thermometer (t–t').														Air temp.
t	13	14	15	16	17	18	19	20	21	22	23	24	25	26	t
+ 80	+ 61	+ 59	+ 56	+ 56	+ 54	+ 52	+ 50	+ 47	+ 45	+ 43	+ 40	+ 37	+ 34	+ 31	+ 80
81	62	60	59	57	55	53	51	49	47	44	42	39	36	33	81
82	63	62	60	58	56	54	52	50	48	46	44	41	38	35	82
83	64	63	61	60	58	56	54	52	50	47	45	43	40	37	83
84	66	64	62	61	59	57	55	53	51	49	47	44	42	39	84
+ 85	+ 67	+ 65	+ 64	+ 62	+ 60	+ 58	+ 57	+ 55	+ 52	+ 50	+ 48	+ 46	+ 43	+ 41	+ 85
86	68	66	65	63	62	60	58	56	54	52	50	47	45	43	86
87	69	67	66	64	63	61	59	57	55	53	51	49	47	44	87
88	70	69	67	66	64	62	60	59	57	55	53	50	48	46	88
89	72	70	68	67	65	64	62	60	58	56	54	52	50	48	89
+ 90	+ 73	+ 71	+ 70	+ 68	+ 66	+ 65	+ 63	+ 61	+ 59	+ 58	+ 56	+ 54	+ 51	+ 49	+ 90
91	74	72	71	69	68	66	64	62	61	59	57	55	53	51	91
92	75	73	72	70	69	67	66	64	62	62	58	56	54	52	92
93	76	74	73	72	70	68	67	65	63	62	60	58	56	54	93
94	77	70	74	73	71	70	68	66	65	63	61	59	57	55	94
+ 95	+ 78	+ 77	+ 75	+ 74	+ 72	+ 71	+ 69	+ 68	+ 66	+ 64	+ 62	+ 60	+ 59	+ 57	+ 95
96	79	78	76	75	74	72	70	69	67	65	64	62	60	58	96
97	80	79	78	76	75	73	72	70	68	67	65	63	61	60	97
98	82	80	79	77	76	74	73	71	70	68	66	65	63	61	98
99	83	81	80	78	77	76	74	72	71	69	68	66	64	62	99
+100	+ 84	+ 82	+ 81	+ 80	+ 78	+ 77	+ 75	+ 74	+ 72	+ 70	+ 69	+ 67	+ 65	+ 64	+100
101	85	83	82	81	79	78	76	75	73	72	70	68	67	65	101
102	86	84	83	82	80	79	78	76	74	73	71	70	68	66	102
103	87	86	84	83	82	80	79	77	76	74	73	71	69	68	103
104	88	87	85	84	83	81	80	78	77	75	74	72	71	69	104
+105	+ 89	+ 88	+ 86	+ 85	+ 84	+ 82	+ 81	+ 80	+ 78	+ 77	+ 75	+ 74	+ 72	+ 70	+105
106	90	89	88	86	85	84	82	81	79	78	76	75	73	72	106
107	91	90	89	87	86	85	83	82	80	79	77	76	74	73	107
108	92	91	90	88	87	86	84	83	82	80	79	77	76	74	108
109	93	92	91	90	88	87	86	84	83	81	80	78	77	75	109
+110	+ 94	+ 93	+ 92	+ 91	+ 89	+ 88	+ 87	+ 85	+ 84	+ 82	+ 81	+ 80	+ 78	+ 76	+110
111	96	94	93	92	90	89	88	86	85	84	82	81	79	78	111
112	97	95	94	93	92	90	89	88	86	85	83	82	80	79	112
113	98	96	95	94	93	91	90	89	87	86	84	83	82	80	113
114	99	98	96	95	94	92	91	90	88	87	86	84	83	81	114
+115	+100	+ 99	+ 97	+ 96	+ 95	+ 94	+ 92	+ 91	+ 90	+ 88	+ 87	+ 85	+ 84	+ 82	+115
116	101	100	98	97	96	95	93	92	91	89	88	86	85	84	116
117	102	101	100	98	97	96	94	93	92	90	89	88	86	85	117
118		102	101	99	98	97	96	94	93	92	90	89	88	86	118
119			102	100	99	98	97	95	94	93	91	90	89	87	119
+120				+101	+100	+ 99	+ 98	+ 96	+ 95	+ 94	+ 92	+ 91	+ 90	+ 88	+120
121					101	100	99	98	96	95	94	92	91	90	121
122						101	100	99	97	96	95	93	92	91	122
123							101	100	98	97	96	94	93	92	123
124								101	100	98	97	96	94	93	124
+125									+101	+ 99	+ 98	+ 97	+ 95	+ 94	+125
126										100	99	98	97	95	126
127											100	99	98	96	127
128												100	99	98	128
129													100	99	129
+130														+100	+130
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	

TABLE V. DEW-POINT.

Barometric pressure, 18.0 *inches*.

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
−20	−20	−31													−20
19	19	29													19
18	18	27													18
17	17	26													17
−16	−16	−24													−16
−15	−15	−23													−15
14	14	22													14
13	13	20	−31												13
12	12	19	29												12
−11	−11	−18	−27												−11
−10	−10	−17	−25												−10
9	9	15	24												9
8	8	14	22												8
7	7	13	20	−30											7
− 6	− 6	−12	−19	−28											− 6
− 5	− 5	−11	−17	−26											− 5
4	4	9	16	24											4
3	3	8	14	22											3
2	2	7	12	20	−31										2
− 1	− 1	− 6	−11	−18	−28										1
0	0	− 4	−10	−16	−25										0
+ 1	+ 1	3	8	15	23										+ 1
2	2	2	7	13	21										2
3	3	− 1	6	11	18	−30									3
4	4	0	− 5	−10	−16	−27									4
+ 5	+ 5	+ 1	− 3	− 8	−14	−24									+ 5
6	6	2	2	7	13	21									6
7	7	3	− 1	6	11	19	−30								7
8	8	4	0	4	9	16	27								8
9	9	6	+ 2	− 3	− 7	−14	−24								9
+10	+10	+ 7	+ 3	− 1	− 6	−12	−21								+10
11	11	8	4	0	4	10	18	−29							11
12	12	9	6	+ 2	3	8	16	25							12
13	13	10	7	3	− 1	6	13	22							13
14	14	11	8	4	0	− 5	−11	−19	−30						14
+15	+15	+12	+ 9	+ 6	+ 2	− 3	− 9	−16	−26						+15
16	16	13	10	7	3	− 2	7	13	22						16
17	17	14	11	8	5	0	5	11	19						17
18	18	16	13	10	6	+ 2	3	9	16	−27					18
19	19	17	14	11	8	4	− 1	− 6	−13	−23					19
+20	+20	+18	+15	+12	+ 9	+ 5	+ 1	− 4	−10	−19					+20
21	21	19	16	14	10	7	3	2	8	16	−28				21
22	22	20	17	15	12	8	4	− 1	6	13	23				22
23	23	21	18	16	13	10	6	+ 2	3	10	19				23
24	24	22	19	17	14	11	8	− 4	− 1	− 7	−15	−27			24
+25	+25	+23	+20	+18	+16	+12	+ 9	+ 5	+ 1	− 5	−12	−22			+25
26	26	24	22	19	17	14	11	7	3	− 2	9	18	−30		26
27	27	25	23	20	18	15	12	9	5	0	6	14	24		27
28	28	26	24	22	19	16	14	10	7	+ 2	3	10	20		28
29	29	27	25	23	20	18	15	12	8	4	− 1	− 7	−15	−28	29
+30	+30	+28	+26	+24	+22	+19	+16	+13	+10	+ 6	+ 1	− 4	−11	−22	+30
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE V. DEW-POINT.

Barometric pressure, 18.0 *inches*.

Air temp. t	Depression of the wet-bulb thermometer (t–t′).														Air temp. t
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	
+30	+30	+28	+26	+24	+22	+19	+16	+13	+10	+ 6	+ 1	− 4	−11	−22	+30
31	31	28	27	25	23	20	18	15	12	8	3	− 2	8	17	31
32	32	29	28	26	24	22	19	16	14	10	6	+ 1	5	13	32
33	33	31	29	27	25	23	20	18	15	11	8	3	− 2	9	33
34	34	32	30	28	26	24	22	19	16	13	10	5	0	6	34
+35	+35	+33	+31	+29	+27	+25	+23	+20	+18	+15	+11	+ 7	+ 3	− 3	+35
36	36	34	32	30	27	26	24	22	19	16	13	9	5	0	36
37	37	35	33	31	28	26	25	23	20	18	15	11	7	+ 2	37
38	38	36	34	32	30	27	25	24	22	19	16	13	9	5	38
39	39	37	35	33	31	28	26	24	23	21	18	15	11	7	39
+40	+40	+38	+36	+34	+32	+30	+27	+25	+22	+22	+19	+16	+13	+ 9	+40
41	41	39	37	35	33	31	28	26	24	21	21	18	15	11	41
42	42	40	38	36	34	32	30	27	25	22	19	20	17	13	42
43	43	41	39	37	35	33	31	29	26	24	20	17	18	15	43
44	44	42	40	38	36	34	32	30	28	25	22	19	16	17	44
+45	+45	+43	+41	+40	+38	+36	+33	+31	+29	+26	+24	+20	+17	+14	+45
46	46	44	42	41	39	37	34	32	30	28	25	22	19	15	46
47	47	45	44	42	40	38	36	34	31	29	26	24	21	17	47
48	48	46	45	43	41	39	37	35	32	30	28	25	22	19	48
49	49	47	46	44	42	40	38	36	34	31	29	26	24	20	49
+50	+50	+48	+47	+45	+43	+41	+39	+37	+35	+33	+30	+28	+25	+22	+50
51	51	49	48	46	44	42	40	38	36	34	32	29	26	24	51
52	52	50	49	47	45	44	42	40	38	35	33	30	28	25	52
53	53	51	50	48	46	45	43	41	39	37	34	32	29	27	53
54	54	52	51	49	48	46	44	42	40	38	36	33	31	28	54
+55	+55	+53	+52	+50	+49	+47	+45	+43	+41	+39	+37	+35	+32	+30	+55
56	56	54	53	51	50	48	46	44	42	40	38	36	34	31	56
57	57	55	54	52	51	49	47	46	44	42	40	37	35	33	57
58	58	56	55	53	52	50	48	47	45	43	41	39	36	34	58
59	59	57	56	54	53	51	50	48	46	44	42	40	38	36	59
+60	+60	+59	+57	+56	+54	+52	+51	+49	+47	+45	+43	+41	+39	+37	+60
61	61	60	58	57	55	53	52	50	48	46	44	43	41	38	61
62	62	61	59	58	56	54	53	51	50	48	46	44	42	40	62
63	63	62	60	59	57	56	54	52	51	49	47	45	43	41	63
64	64	63	61	60	58	57	55	53	52	50	48	46	44	42	64
+65	+65	+64	+62	+61	+59	+58	+56	+54	+53	+51	+49	+48	+46	+44	+65
66	66	65	63	62	60	59	57	56	54	52	50	49	47	45	66
67	67	66	64	63	61	60	58	57	55	54	52	50	48	46	67
68	68	67	65	64	62	61	59	58	56	55	53	51	49	48	68
69	69	68	66	65	63	62	60	59	57	56	54	52	51	49	69
+70	70	+69	+67	+66	+64	+63	+62	+60	+58	+57	+55	+54	+52	+50	+70
71	71	70	68	67	66	64	63	61	60	58	56	55	53	51	71
72	72	71	69	68	67	65	64	62	61	59	58	56	54	52	72
73	73	72	70	69	68	66	65	63	62	60	59	57	55	54	73
74	74	73	71	70	69	67	66	64	63	61	60	58	57	55	74
+75	75	74	+72	+71	+70	+68	+67	+65	+64	+62	+61	+59	+58	+56	+75
76	76	75	73	72	71	69	68	66	65	64	62	60	59	57	76
77	77	76	74	73	72	70	69	68	66	65	63	62	60	58	77
78	78	77	75	74	73	71	70	69	67	66	64	63	61	60	78
79	79	78	76	75	74	72	71	70	68	67	65	64	62	61	79
+80	80	+79	+77	+76	+75	+74	+72	+71	+69	+68	+66	+65	+64	+62	+80
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE V.

DEW-POINT.

Barometric pressure, 18.0 *inches*.

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	13	14	15	16	17	18	19	20	21	22	23	24	25	26	t
+30	−22														+30
31	17														31
32	13	−25													32
33	9	20													33
34	− 6	−15	−27												34
+35	− 3	−10	−21												+35
36	0	7	16	−29											36
37	+ 2	4	11	22											37
38	5	− 1	7	16											38
39	7	+ 2	− 4	−12	−24										39
+40	+ 9	+ 5	− 1	− 8	−18										+40
41	11	7	+ 2	4	13	−26									41
42	13	9	5	− 1	8	19									42
43	15	11	7	+ 2	4	13	−26								43
44	17	13	9	5	− 1	− 9	−19								44
+45	+14	+15	+12	+ 7	+ 2	− 5	−13	−27							+45
46	15	11	14	10	5	− 1	8	19							46
47	17	13	9	12	7	+ 2	4	13	−28						47
48	19	15	11	6	10	5	− 1	8	20						48
49	20	17	13	9	3	8	+ 2	− 4	−14	−28					49
+50	+22	+19	+15	+11	+ 6	− 1	+ 5	− 1	− 8	−20					+50
51	24	21	17	13	8	+ 2	− 5	+3	4	14	−28				51
52	25	22	19	15	11	6	− 4	−10	0	8	20				52
53	27	24	21	17	13	8	+ 2	6	−18	4	13	−27			53
54	28	25	22	19	16	11	6	− 1	−11	−28	− 8	−19			54
+55	+30	+27	+24	+21	+18	+13	+ 8	+ 2	− 6	−19		−12	−27		+55
56	31	28	26	23	19	16	11	6	− 2	12	−29		−18		56
57	33	30	27	24	21	18	14	9	+ 2	6	19				57
58	34	31	29	26	23	20	16	12	6	− 2	12	29			58
59	36	33	30	28	25	22	18	14	9	+ 2	− 6	19			59
+60	+37	+34	+32	+29	+26	+23	+20	+16	+12	+ 6	− 1	−11	−30		+60
61	38	36	34	31	28	25	22	18	14	9	+ 3	6	19		61
62	40	37	35	32	30	27	24	20	17	12	6	− 1	11	−30	62
63	41	39	36	34	31	29	26	22	19	15	10	+ 3	− 5	19	63
64	42	40	38	36	34	30	27	24	21	17	12	7	0	−11	64
+65	+44	+42	+39	+37	+35	+32	+29	+26	+23	+19	+15	+10	+ 4	− 5	+65
66	45	43	41	38	36	34	31	28	25	21	18	13	8	0	66
67	46	44	42	40	38	35	32	30	27	23	20	16	11	+ 4	67
68	48	46	44	41	39	37	34	31	28	25	22	18	14	8	68
69	49	47	45	43	40	38	36	33	30	27	24	20	16	11	69
+70	+50	+48	+46	+44	+42	+40	+37	+35	+32	+29	+26	+23	+19	+14	+70
71	51	49	48	46	44	41	39	36	34	31	28	25	21	17	71
72	52	51	49	47	45	43	40	38	35	32	30	27	23	19	72
73	54	52	50	48	46	44	42	40	37	34	32	28	25	22	73
74	55	53	51	50	48	45	43	41	39	36	33	30	27	24	74
+75	+56	+54	+53	+51	+49	+47	+45	+43	+40	+38	+35	+32	+29	+26	+75
76	57	56	54	52	50	48	46	44	42	39	37	34	31	28	76
77	58	57	55	53	51	50	48	46	43	41	38	36	33	30	77
78	60	58	56	54	53	51	49	47	45	42	40	38	35	32	78
79	61	59	58	56	54	52	50	48	46	44	41	39	37	34	79
+80	+62	+60	+59	+57	+55	+54	+52	+50	+48	+46	+43	+41	+38	+36	+80
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	

TABLE V. DEW-POINT.

Barometric pressure, 18.0 *inches.*

Air temp.	Depression of the wet-bulb thermometer (t–t′).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
+ 80	+ 0	+ 79	+ 77	+ 76	+ 75	+ 74	+ 72	+ 71	+ 69	+ 68	+66	+ 65	+ 64	+ 62	+ 80
81	81	80	78	77	76	75	73	72	70	69	68	66	65	63	81
82	82	81	79	78	77	76	74	73	72	70	69	67	66	64	82
83	83	82	80	79	78	77	75	74	73	71	70	68	67	65	83
84	84	83	81	80	79	78	76	75	74	72	71	70	68	66	84
+ 85	+ 85	+ 84	+ 82	+ 81	+ 80	+ 79	+ 77	+ 76	+ 75	+ 73	+ 72	+ 71	+ 69	+ 68	+ 85
86	86	85	83	82	81	80	78	77	76	74	73	72	70	69	86
87	87	86	85	83	82	81	80	78	77	76	74	73	71	70	87
88	88	87	86	84	83	82	81	79	78	77	75	74	72	71	88
89	89	88	87	85	84	83	82	80	79	78	76	75	74	72	89
+ 90	+ 90	+ 89	+ 88	+ 86	+ 85	+ 84	+ 83	+ 81	+ 80	+ 79	+ 77	+ 76	+ 75	+ 73	+ 90
91	91	90	89	87	86	85	84	82	81	80	78	77	76	74	91
92	92	91	90	88	87	86	85	83	82	81	80	78	77	76	92
93	93	92	91	89	88	87	86	84	83	82	81	79	78	77	93
94	94	93	92	90	89	88	87	86	84	83	82	80	79	78	94
+ 95	+ 95	+ 94	+ 93	+ 91	+ 90	+ 89	+ 88	+ 87	+ 85	+ 84	+ 83	+ 81	+ 80	+ 79	+ 95
96	96	95	94	92	91	90	89	88	86	85	84	82	81	80	96
97	97	96	95	93	92	91	90	89	87	86	85	84	82	81	97
98	98	97	96	94	93	92	91	90	88	87	86	85	83	82	98
99	99	98	97	95	94	93	92	91	89	88	87	86	84	83	99
+100	+100	+ 99	+ 98	+ 96	+ 95	+ 94	+ 93	+ 92	+ 90	+ 89	+ 88	+ 87	+ 86	+ 84	+100
101	101	100	99	97	96	95	94	93	92	90	89	88	87	85	101
102	102	101	100	98	97	96	95	94	93	91	90	89	88	86	102
103	103	102	101	100	98	97	96	95	94	92	91	90	89	87	103
104	104	103	102	101	99	98	97	96	95	94	92	91	90	88	104
+105		+104	+103	+102	+100	+ 99	+ 98	+ 97	+ 96	+ 95	+ 93	+ 92	+ 91	+ 90	+105
106			104	103	101	100	99	98	97	96	94	93	92	91	106
107				104	102	101	100	99	98	97	95	94	93	92	107
108					103	102	101	100	99	98	96	95	94	93	108
109						103	102	101	100	99	97	96	95	94	109
+110							+103	+102	+101	+100	+ 98	+ 97	+ 96	+ 95	+110
111								103	102	101	100	98	97	96	111
112									103	102	101	99	98	97	112
113										103	102	100	99	98	113
114											103	101	100	99	114
+115												+102	+101	+100	+115
116													102	101	116
117														102	117
118															118
119															119
+120															+120
121															121
122															122
123															123
124															124
+125															+125
126															126
127															127
128															128
129															129
+130															+130
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE V. DEW-POINT.

Barometric pressure, 18.0 *inches.*

Air temp.	Depression of the wet-bulb thermometer (t—t′).														Air temp.
t	13	14	15	16	17	18	19	20	21	22	23	24	25	26	t
+ 80	+ 62	+ 60	+ 59	+ 57	+ 55	+ 54	+ 52	+ 50	+ 48	+ 46	+ 43	+ 41	+ 38	+ 36	+ 80
81	63	62	60	58	56	55	53	51	49	47	45	43	40	37	81
82	64	63	61	60	58	56	54	52	50	48	46	44	42	39	82
83	65	64	62	61	59	57	56	54	52	50	48	46	43	41	83
84	66	65	64	62	60	58	57	55	53	51	49	47	45	43	84
+ 85	+ 68	+ 66	+ 65	+ 63	+ 61	+ 60	+ 58	+ 56	+ 54	+ 53	+ 51	+ 49	+ 46	+ 44	+ 85
86	69	67	66	64	63	61	59	58	56	54	52	50	48	46	86
87	70	68	67	65	64	62	61	59	57	55	53	52	49	47	87
88	71	70	68	67	65	64	62	60	58	57	55	53	51	49	88
89	72	71	69	68	66	65	63	61	60	58	56	54	52	50	89
+ 90	+ 73	+ 72	+ 70	+ 69	+ 67	+ 66	+ 64	+ 63	+ 61	+ 59	+ 58	+ 56	+ 54	+ 52	+ 90
91	74	73	72	70	69	67	66	64	62	60	59	57	55	53	91
92	76	74	73	71	70	68	67	65	64	62	60	58	56	55	92
93	77	75	74	72	71	69	68	66	65	63	61	60	58	56	93
94	78	76	75	74	72	71	69	68	66	64	63	61	59	57	94
+ 95	+ 79	+ 77	+ 76	+ 75	+ 73	+ 72	+ 70	+ 69	+ 67	+ 66	+ 64	+ 62	+ 60	+ 59	+ 95
96	80	78	77	76	74	73	71	70	68	67	65	64	62	60	96
97	81	80	78	77	76	74	73	71	70	68	66	65	63	61	97
98	82	81	79	78	77	75	74	72	71	69	68	66	64	63	98
99	83	82	80	79	78	76	75	74	72	70	69	67	66	64	99
+100	+ 84	+ 83	+ 82	+ 80	+ 79	+ 77	+ 76	+ 75	+ 73	+ 72	+ 70	+ 69	+ 67	+ 65	+100
101	85	84	83	81	80	79	77	76	74	73	71	70	68	67	101
102	86	85	84	82	81	80	78	77	76	74	72	71	70	68	102
103	87	86	85	84	82	81	80	78	77	75	74	72	71	69	103
104	88	87	86	85	83	82	81	79	78	76	75	73	72	70	104
+105	+ 90	+ 88	+ 87	+ 86	+ 84	+ 83	+ 82	+ 80	+ 79	+ 78	+ 76	+ 75	+ 73	+ 72	+105
106	91	89	88	87	86	84	83	82	80	79	77	76	74	73	106
107	92	90	89	88	87	85	84	83	81	80	78	77	76	74	107
108	93	92	90	89	88	86	85	84	82	81	80	78	77	75	108
109	94	93	91	90	89	88	86	85	84	82	81	79	78	76	109
+110	+ 95	+ 94	+ 92	+ 91	+ 90	+ 89	+ 87	+ 86	+ 85	+ 83	+ 82	+ 80	+ 79	+ 78	+110
111	96	95	93	92	91	90	88	87	86	84	83	82	80	79	111
112	97	96	94	93	92	91	90	88	87	86	84	83	81	80	112
113	98	97	96	94	93	92	91	89	88	87	85	84	83	81	113
114	99	98	97	95	94	93	92	90	89	88	86	85	84	82	114
+115	+100	+ 99	+ 98	+ 96	+ 95	+ 94	+ 93	+ 92	+ 90	+ 89	+ 88	+ 86	+ 85	+ 84	+115
116	101	100	99	98	96	95	94	93	91	90	89	87	86	85	116
117	102	101	100	99	97	96	95	94	92	91	90	88	87	86	117
118		102	101	100	98	97	96	95	94	92	91	90	88	87	118
119			102	101	100	98	97	96	95	93	92	91	89	88	119
+120				+102	+101	+ 99	+ 98	+ 97	+ 96	+ 94	+ 93	+ 92	+ 90	+ 89	+120
121					102	100	99	98	97	96	94	93	92	90	121
122						102	100	99	98	97	95	94	93	92	122
123							101	100	99	98	96	45	94	93	123
124								101	100	99	98	96	95	94	124
+125									+101	+100	+ 99	+ 97	+ 96	+ 95	+125
126										101	100	98	97	96	126
127											101	100	98	97	127
128												101	99	98	128
129													100	99	129
+130														+100	+130
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	

TABLE VI. RELATIVE HUMIDITY.

For all latitudes, elevations, and pressures.

Air temp.	Depression of the dew-point (t–d).														Air temp.
t	0	1	2	3	4	5	6	7	8	9	10	11	12	13	t
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	
— 68	100														— 68
— 64	100														— 64
— 60	100	64	29												— 60
— 56	100	84	68	53	38	24	11								— 56
— 52	100	89	78	68	58	48	39	31	22	14	6				— 52
— 48	100	91	83	74	67	59	52	45	38	32	27	21	15	9	— 48
— 44	100	92	85	78	72	65	59	53	48	42	37	32	28	23	— 44
— 40	100	93	87	81	75	69	64	59	54	49	44	40	36	32	— 40
— 36	100	94	87	82	77	72	67	62	58	53	49	45	41	37	— 36
— 32	100	94	88	83	79	74	69	65	61	57	53	49	45	42	— 32
— 28	100	94	89	84	80	75	71	67	63	59	55	52	48	45	— 28
— 24	100	95	90	85	80	76	72	68	64	61	57	53	50	47	— 24
— 20	100	95	90	85	80	76	72	68	64	60	57	53	51	48	— 26
— 16	100	95	90	86	81	77	73	69	65	62	58	55	52	49	— 16
— 12	100	95	90	86	82	78	74	70	67	63	60	57	54	50	— 12
— 8	100	95	91	86	82	78	74	71	67	64	61	58	55	52	— 8
— 4	100	95	91	87	83	79	75	71	68	65	62	58	56	53	— 4
0	100	95	91	87	83	79	75	72	68	65	62	59	56	54	0
+ 4	100	96	91	87	83	79	76	72	69	66	63	60	57	54	+ 4
8	100	96	91	87	83	80	76	73	69	66	63	60	58	55	8
+ 12	100	96	91	87	83	80	76	73	70	66	64	61	58	55	+ 12
16	100	96	91	87	83	80	76	73	70	67	64	61	58	56	16
20	100	96	91	87	84	80	76	73	70	67	64	61	58	56	20
24	100	96	92	88	84	80	76	73	70	67	64	61	58	56	24
28	100	96	92	88	84	80	77	74	70	67	64	61	59	56	28
+ 32	100	96	92	88	85	81	78	74	71	68	65	62	60	57	+ 32
36	100	96	92	89	85	82	79	75	72	69	66	64	61	58	36
40	100	96	92	89	86	82	79	76	73	70	67	65	62	59	40
44	100	96	93	89	86	83	80	76	74	71	68	65	63	60	44
48	100	96	93	89	86	83	80	77	74	71	68	66	63	61	48
+ 52	100	96	93	90	86	83	80	77	74	72	69	66	64	61	+ 52
56	100	96	93	90	86	83	80	77	74	72	69	67	64	62	56
60	100	96	93	90	87	84	81	78	75	72	70	67	65	62	60
64	100	97	93	90	87	84	81	78	75	73	70	68	65	63	64
68	100	97	93	90	87	84	81	78	76	73	70	68	66	63	68
+ 72	100	97	94	90	87	84	82	79	76	73	71	68	66	64	+ 72
76	100	97	94	90	88	85	82	79	76	74	71	69	66	64	76
80	100	97	94	91	88	85	82	79	77	74	72	69	67	65	80
84	100	97	94	91	88	85	82	80	77	74	72	70	67	65	84
88	100	97	94	91	88	85	82	80	77	75	72	70	68	66	88
+ 92	100	97	94	91	88	85	83	80	78	75	73	70	68	66	+ 92
96	100	97	94	91	88	86	83	80	78	76	73	71	69	66	96
100	100	97	94	91	88	86	83	81	78	76	74	71	69	67	100
104	100	97	94	91	89	86	84	81	79	76	74	72	69	67	104
108	100	97	94	92	89	86	84	81	79	76	74	72	70	68	108
+112	100	97	94	92	89	86	84	82	79	77	74	72	70	68	+112
116	100	97	94	92	89	87	84	82	80	77	75	73	71	68	116
120	100	97	95	92	89	87	84	82	80	77	75	73	71	69	120
124	100	97	95	92	90	87	85	82	80	78	76	74	71	69	124
128	100	97	95	92	90	87	85	82	80	78	76	74	72	70	128
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	

TABLE VI. RELATIVE HUMIDITY.

For all latitudes, elevations, and pressures.

Air temp.	Depression of the dew-point (t-d).														Air temp
t	13	14	15	16	17	18	19	20	21	22	23	24	25	26	t
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	
− 68															− 68
− 64															− 64
− 60															− 60
− 56															− 56
− 52															− 52
− 48	9	4													− 48
− 44	23	19	15	11	7	3									− 44
− 40	32	28	24	21	17	14	11	8	5	2					− 40
− 36	37	34	31	28	24	21	18	16	13	11	8	6	4	2	− 36
− 32	42	39	35	32	29	27	24	22	19	17	14	12	10	8	− 32
− 28	45	42	39	36	33	31	28	26	23	21	19	17	15	13	− 28
− 24	47	44	41	38	36	33	31	29	26	24	22	21	19	17	− 24
− 20	48	45	43	40	38	35	34	32	29	27	25	23	21	20	− 20
− 16	49	46	44	41	40	37	35	33	31	29	27	25	23	22	− 16
− 12	50	47	45	42	41	38	36	34	32	30	28	27	25	24	− 12
− 8	52	49	46	44	42	39	37	35	33	31	29	28	26	25	− 8
− 4	53	50	48	45	43	41	38	36	34	32	31	29	27	26	− 4
0	54	51	48	46	44	42	39	37	36	34	32	30	29	27	0
+ 4	54	52	49	47	45	42	40	38	36	35	33	31	30	28	+ 4
8	55	52	50	48	45	43	41	39	37	35	34	32	30	29	8
+ 12	55	53	50	48	46	44	42	40	38	36	34	32	31	30	+ 12
16	56	53	51	48	46	44	42	40	38	36	35	33	32	30	16
20	56	53	51	48	46	44	42	40	38	37	35	33	32	30	20
24	56	53	51	48	46	44	42	40	39	37	35	34	32	31	24
28	56	54	51	49	47	45	43	41	39	37	36	34	32	31	28
+ 32	57	54	52	50	47	45	43	41	40	38	36	34	33	32	+ 32
36	58	56	53	51	49	46	44	42	40	39	37	35	34	33	36
40	59	57	54	52	50	48	46	43	42	40	38	36	35	33	40
44	60	58	56	53	51	49	47	45	43	41	39	37	36	34	44
48	61	58	56	54	52	50	48	46	44	42	40	38	37	35	48
+ 52	61	59	57	55	52	50	48	47	44	43	41	40	38	36	+ 52
56	62	60	57	55	53	51	49	47	45	44	42	40	39	37	56
60	62	60	58	56	54	52	50	48	46	44	42	41	39	38	60
64	63	60	58	56	54	52	50	48	47	45	43	42	40	39	64
68	63	61	59	57	55	53	51	49	47	45	44	42	40	39	68
+ 72	64	62	59	57	55	53	51	50	48	46	44	43	41	40	+ 72
76	64	62	60	58	56	54	52	50	48	47	45	43	42	41	76
80	65	62	60	58	56	54	52	51	49	47	46	44	42	41	80
84	65	63	61	59	57	55	53	51	49	48	46	44	43	42	84
88	66	63	61	59	57	55	54	52	50	48	47	45	44	43	88
+ 92	66	64	62	60	58	56	54	52	50	49	47	46	44	43	+ 92
96	66	64	62	60	58	56	55	53	51	49	48	46	45	44	96
100	67	65	63	61	59	57	55	53	52	50	48	47	45	44	100
104	67	65	63	61	59	58	56	54	53	51	49	47	46	45	104
108	68	66	64	62	60	58	56	54	53	51	49	48	46	45	108
+112	68	66	64	62	60	58	57	55	54	52	50	48	47	46	+112
116	68	66	64	63	61	59	57	56	54	52	50	49	48	47	116
120	69	67	65	63	61	60	58	56	54	52	51	50	48	47	120
124	69	67	65	64	62	60	58	56	55	53	51	50	49	48	124
128	70	68	66	64	62	60	59	57	55	53	52	51	49	48	128
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	

TABLE VI. RELATIVE HUMIDITY.

For all latitudes, elevations, and pressures.

Air temp.	Depression of the dew-point (t–d).											Air temp.
t	20	24	28	32	36	40	44	48	52	56	60	t
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
— 68												— 68
64												64
60												60
56												56
— 52												— 52
— 48												— 48
44												44
40	8											40
36	16	6										36
— 32	22	12	5									— 32
— 28	26	17	10	4								— 23
24	29	21	14	8	3							24
20	32	23	17	11	7	3						20
16	33	25	19	13	9	5						16
— 12	34	27	21	15	11	7	3					— 12
— 8	35	28	23	17	13	9	5	4				— 8
— 4	36	29	24	19	15	11	7	6	3			— 4
0	37	30	25	20	16	12	9	7	4	3		0
+ 4	38	31	26	21	17	13	10	8	5	4		+ 4
8	39	32	27	22	18	14	11	9	6	5	3	8
+ 12	40	32	27	22	18	14	11	10	7	6	4	+ 12
16	40	33	27	22	18	15	12	10	7	6	4	16
20	40	33	28	23	19	15	12	10	8	6	5	20
24	40	34	28	23	19	15	13	11	8	7	5	24
28	41	34	28	23	19	16	13	11	9	7	6	28
+ 32	41	34	29	24	20	16	14	11	9	7	6	+ 32
36	42	35	30	25	20	17	14	12	10	8	6	36
40	43	36	30	25	21	18	14	12	10	8	6	40
44	45	37	31	26	22	18	15	12	10	8	7	44
48	46	38	32	27	22	19	16	13	11	9	7	48
+ 52	47	40	33	28	23	19	16	13	11	9	8	+ 52
56	47	40	34	29	24	20	17	14	12	10	8	56
60	48	41	35	30	25	21	17	14	12	10	8	60
64	48	42	36	30	26	22	18	15	12	10	9	64
68	49	42	36	31	26	22	19	16	13	11	9	68
+ 72	50	43	37	32	27	23	19	16	14	11	10	+ 72
76	50	43	37	32	28	24	20	17	14	12	10	76
80	51	44	38	33	28	24	21	18	15	13	10	80
84	51	44	39	33	29	25	21	18	16	13	11	84
88	52	45	39	34	29	25	22	19	16	14	12	88
+ 92	52	46	40	34	30	26	22	19	16	14	12	+ 92
96	53	46	40	35	30	26	23	20	17	15	12	96
100	53	47	41	36	31	27	23	20	17	15	13	100
104	54	47	41	36	32	28	24	21	18	16	13	104
108	54	48	42	37	32	28	24	21	18	16	14	108
+112	55	48	43	37	33	29	25	22	19	16	14	+112
116	56	49	43	38	33	29	26	22	20	17	15	116
120	56	50	44	39	34	30	26	23	20	18	15	120
124	56	50	44	39	35	30	27	23	20	18	16	124
128	57	51	45	40	35	31	27	24	21	18	16	128
	20	24	28	32	36	40	44	48	52	56	60	

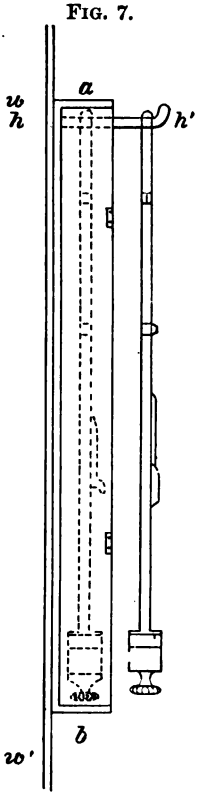
THE BAROMETER.

The Toricellian tube furnishes the means of measuring the amount of the atmospheric pressure at any moment; and this pressure may be expressed by the height of the column of mercury which it supports. Such an instrument is called a *barometer*. In order that its indications may be accurate, several precautions must be observed. In the first place, the kind of liquid used in different barometers must be identical, for the height of the column supported naturally depends upon the density of the liquid employed, and if this varies the observations made with different instruments will not be comparable.

The mercury employed should be chemically pure. The barometric tube is filled nearly full, and is then placed upon a sloping furnace and heated until the mercury boils. The object of this process is to expel the air and moisture which may be contained in the mercurial column, and which, without this precaution, would gradually ascend into the vacuum above, cause a downward pressure of unknown amount, and prevent the mercury from rising to the proper height.

The next step is to fill up the tube with pure mercury, taking care not to introduce any bubble of air. The tube is then inverted in a cistern, likewise containing pure mercury recently boiled, and is firmly fixed in a vertical position. This is a fixed barometer, and in order to ascertain the atmospheric pressure at any moment it is only necessary to measure the height of the top of the column of mercury above the surface of the mercury in the cistern. For this purpose an ivory point, the lower extremity of which is the zero of the scale, is fixed to the frame-work of the instrument, on the upper portion of which is the graduated scale and vernier. The mercury in the cistern is brought in contact with the ivory point and the vernier of the scale is adjusted to the top of the column; the reading of the scale will then give the height of the column of mercury.

FIG. 7.



Placing.—The barometer should be placed in a room of a temperature as uniform as possible, and not exposed to the sun. It must be suspended so that the top of the column will be at the height of the eye, near a window, in such a manner as to be lighted perfectly without exposure either to the direct rays of the sun, or to the currents of the air which always take place at the joinings of the windows. When the barometer has to be fixed to the wall, as is the case with all the self-recording and some other barometers, care must be taken to secure the tube in a position perfectly vertical, regulating it by the plumb-line, first in front, then at the sides, at least in two vertical planes cutting each other at right angles. When the instrument is so constructed as to take its equilibrium itself, as the Fortin barometers and those of J. Green, it is enough to hang it on a strong hook. These conditions being fulfilled, the rest of the arrangement may be varied according to the nature of the localities. For the Fortin and Green barometers, the following arrangement is convenient, and may be almost everywhere adopted. (*See* Fig. 7.)

A small oblong box (*a b*), some inches longer than the barometer, and

a little broader than its cistern, is firmly set against the wall (*w w'*), near the window, in such a manner as to open in a direction parallel to the panes; at the summit (*a*) it has a strong hook (*h h'*), which extends beyond the box about two or three inches, and on which the barometer is suspended. The instrument remains generally in the box, which is closed by a movable cover, and which protects it from external injuries, from dust, and from the direct radiation of warm bodies, or the currents of air from the window, and diminishes the effect of the too sudden variations of temperature. When it is to be observed, the barometer is taken by the upper end of the tube, and the suspending ring is made to slide towards the end of the hook. The instrument is then in the full light of the window, in front of which the observer places himself; the summit of the mercurial column, as well as the surface of the mercury in the cistern, are completely lighted, and the reading becomes easy and certain. Moreover, the slight oscillating movement impressed on the instrument, by changing its place, breaks the adherence of the mercury to the glass, and thus prepares a good observation. After the reading, the barometer is again slipped gently into the box, and this is closed.

Observation.—Note the degree and the tenths of degrees of the thermometer attached to the instrument; for it will be seen that the heat of the observer's body soon makes it rise.

Incline the instrument gently, so as to render the mercurial column very movable; then, after having restored it to rest, strike several slight blows upon the casing, in such a manner as to impress on the mercury gentle vibrations. The adherence of the mercury to the glass will thus be destroyed, and the column will take its true equilibrium.

Bring, by means of the adjusting screw at the bottom, the surface of the mercury to the zero of the scale.

In the barometers with an ivory point, as the Fortin, Newman, and Green barometers, the extremity of this point is the zero of the scale, which must be brought into exact contact with the surface of the mercury. This takes place when the point coincides exactly with its image reflected below by the mercury. This method is very good when the surface of the mercury is perfectly pure and brilliant. It is generally dimmed by a slight layer of oxide, which makes the coincidence of the point with its image uncertain. It is safer to judge of the contact in a different manner. From the moment when the point does more than touch the surface, it forms around itself, by capillary action, a small depression, which, breaking the direction of the reflected rays, becomes immediately very easy to discover. It is enough, then, to raise the mercury so as slightly to immerse the point; then to lower it gradually until the little depression disappears. If care is taken to make a good light fall on that portion of the mercury which is under the point, and to use the aid of a magnifier, the adjustment of the point thus made becomes not only easy, but very certain, and the errors to which we are liable are almost insensible, for they do not exceed two or three hundredths of a millimeter, or a thousandth of an inch.

The level being thus adjusted to the zero of the scale, proceed to observe the height of the summit of the column. Take hold of the instrument with the left hand, above the attached thermometer, without moving it from the vertical; tap it gently in the neighborhood of the top of the column; then, by means of the screw, lower the slide which carries the vernier, until the plane passing through the two lower opposite edges of it is exactly tangent to the summit of the *meniscus*—that is, the convexity which terminates the column. This is the case when, placing the eye exactly at the height of the summit of the column, the

summit of the column is seen without there being any trace of light between the summit and the edge of the ring. To be certain that the barometer has remained quite vertical during its operation, leave it to itself, and, when it is at rest, look again to see whether the ring has remained tangential to the summit of the column. If it has not, the verticality has been disturbed; it must be adjusted anew. It is necessary, at the same time, to examine if the adjustment of the surface of the mercury in the cistern has remained the same.

e. Nothing more, then, remains than to read the instrument. In the English barometers, the inches and tenths of inches are read directly on the scale, the hundredths and thousandths on the vernier. In the French barometers, with the metrical scale, the centimeters and millimeters are read on the scale, and the fractions of millimeters on the vernier. Begin by reading on the scale the number of inches and tenths of an inch, or of millimeters, there are, as far up as the line which corresponds to the *lower* edge of the vernier, and which marks the summit of the column. In the Green barometers, this line marks at the same time the zero of the vernier. If this line does not coincide with one of the divisions of the scale, we read the fraction of the following division on the vernier.

The principle of the vernier is very simple. If we wish to obtain tenths, we divide into ten parts a space on the vernier comprising nine parts of the scale (*see* Fig. 8); each division of the vernier is thus found shorter by a tenth than each division of the scale. Now, if we start from the point where the zero of the vernier and its tenth division coincide exactly with the first and the ninth division of the scale, and if we cause the vernier to move gradually from the ninth to the tenth division of the scale, we shall see the first, the second, the third, and the other divisions of the vernier as far as the tenth, coincide successively with one of the divisions of the scale. Now, the divisions of the scale to which those of the vernier correspond being equal parts, it follows that the space in question has been successively divided into ten parts, or tenths, by these successive coincidences. If the scale bears millimeters, the vernier will give tenths of millimeters; if it has tenths of an inch, the vernier will give hundredths. By changing the proportions, it may be made to indicate by the vernier smaller fractions, as twentieths of millimeters, or five-hundredths of an inch, &c.

To read the vernier, we must look out for the line that coincides with one of the divisions of the scale. The number of this division of the vernier, proceeding from zero, indicates the number of tenths of millimeters, or of hundredths of an inch, which must be added to the whole number given by the scale. If none of the divisions of the scale coincides exactly, we estimate by the eye, in decimals, the quantity by which the vernier must be lowered to obtain a coincidence, and this is added to the fraction already obtained. This will be hundredths of millimeters in the metrical barometer, and thousandths of inches in the English barometers.

The following figures will serve as an example; the instrument is an English barometer:

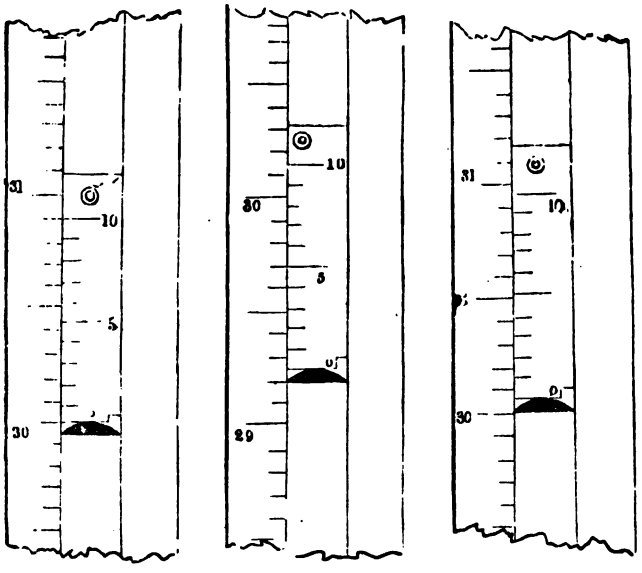
In Fig. 8 the regulating line, which is the lower edge of the vernier ring, coincides exactly with the line of thirty inches on the scale. The zero and the tenth division of the vernier are also in exact coincidence; that is to say, there is no fraction. We shall read then 30.000 inches.

In Fig. 9 the regulating line does not fall upon any of the divisions of the scale, but between twenty-nine inches and two-tenths and twenty-nine inches and three-tenths of an inch. There is then a fraction which

must be read on the vernier. Seeking which of these divisions coincides with that of the scale, we find that it is the fifth; we shall write then 29.250 inches.

In Fig. 10 we see that the height falls between thirty inches and thirty inches and one-tenth; no line of the vernier also coincides exactly; but the line 7 is a little above, the line 8 is a little below, one of the lines of the scale; the fraction falls, then, between seven and eight hundredths. Estimating in tenths the distance the vernier passes over between the coincidence of seven and that of eight, the tenths of an hundredth or the thousandths are obtained. In this latter case, the distance above seven is less than the half; it will then read 30.073. It will always be easy to judge whether the top approaches nearer the upper coincidence

FIG. 8. FIG. 9. FIG. 10.



than the lower coincidence; in the former case, the fraction is greater than .005; in the latter it is smaller than .005. The error which will be committed in this estimate will remain less than .005; with practice and a little skill, it will hardly ever exceed .002, always supposing the scale is well graduated. For this reading, as well as for the others, it is particularly important to have the eye exactly at the height of the line to be determined.

The same process of reading is applied to the metrical scale; the vernier then gives tenths directly, and, by estimate, the hundredths of millimeters. In the English instruments, the inches must be separated by a (.) and three decimals written, even when the last is a zero; *e. g.*, 30.250, and not 30.25; the zero indicates that the thousandths have been taken into account, but that there are none. In the metrical scale put the (.) after the millimeters, and admit two decimals, *e. g.*, 761.25.

During the whole time of the observation of the barometer, the observer must endeavor to protect it as much as possible from the heat which radiates from his body. But the best way is to learn to observe rapidly. All the operations take longer to describe than to execute; one or two minutes, if the instrument be in place, three minutes if it is

to be taken from its case and put back again, are sufficient for a practiced observer to make a good observation.

Altitude.—The height of the barometer above the ground, or above some fixed point, which may serve as an invariable point of reference, ought to be exactly determined. Such a point, for instance, may be the base of a public edifice, the level of low water of a neighboring river, the ordinary level of the surface-water of a canal, the upper part of a wharf in mason-work, &c. If the barometer has changed place, it is again necessary to measure exactly its height above the same point of reference; the latter will serve to fix the height of the barometer and of the station above the level of the ocean; this *datum* being of the greatest importance. Every change of this nature should be carefully noted in the journal.

It is greatly to be desired that the place of the barometer, once determined, should not be changed, either from one story to another, or from one house to another. If circumstances compel this to be done, before taking it from its place, begin by raising the mercury in the cistern by means of the screw, so as to fill the cistern and the tube; it must then be gently taken from the hook, *turned upside down*, and carried with *the cistern up*, taking great care not to strike it against anything. If it were transported without these precautions, even from one chamber to another, great risk would infallibly be run of breaking it, or letting in air, and thus rendering it useless.

Verification.—From time to time the barometer should be so inclined as to cause the mercury to strike gently against the top of the tube. If it gives a dry and clear sound, it is free from air, and the instrument is in good condition. If the sound is flat and muffled, there is a little air in the barometric vacuum; and the fact should be noticed in the journal. Every occasion should be seized to compare it anew with a standard barometer, to ascertain whether it has undergone any change.

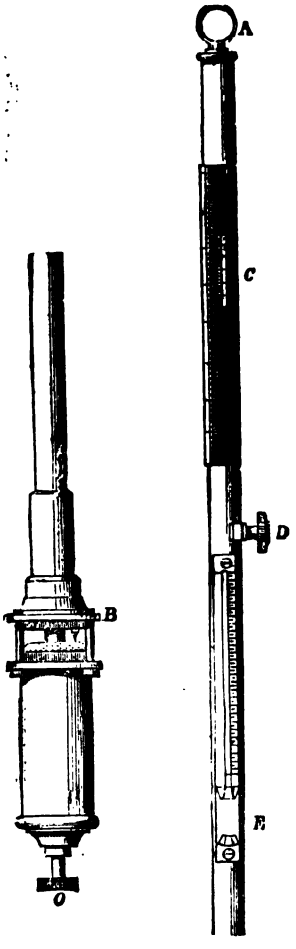
GREEN'S STANDARD BAROMETER.

The following is an account of Green's improved standard barometer.

The barometer consists of a brass tube (Fig. 11), terminating at top in a ring A, for suspension, and at bottom in a flange B, to which the several parts forming the cistern are attached.

The upper part of this tube is cut through so as to expose the glass tube and mercurial column within, seenin Fig. 13. Attached at one side of this opening is a scale, graduated in inches and parts; and inside this slides a short tube *c*, connected to a rack-work arrangement, moved by a milled head D; this sliding tube carries a vernier in contact with the scale, which reads off to $\frac{1}{500}$ (.002) of an inch.

FIG. 11.



In the middle of the brass tube is fixed the thermometer E, the bulb of which being externally covered, but inwardly open, and nearly in contact with the glass tube, indicates the temperature of the mercury in the barometer tube, not that of the external air. This central position of the thermometer is selected that the mean temperature of the whole column may be obtained, a matter of importance, as the temperature of the barometric column must be taken into account in every scientific application of its observed height.

The cistern (Fig. 12) is made up of a glass cylinder F, which allows the surface of the mercury *q* to be seen, and a top plate G, through the neck of which the barometer-tube *t* passes, and to which it is fastened by a piece of kid leather, making a strong but flexible joint. To this plate, also, is attached a small ivory point *h*, the extremity of which marks the commencement or zero of the scale above. The lower part, containing the mercury, in which the end of the barometer-tube *t* is plunged, is formed of two parts *i j*, held together by four screws and two divided rings *l m*, in the manner shown in the Figures 12 and 14. To the lower piece *j* is fastened the flexible bag *N*, made of kid leather, furnished in the middle with a socket *k*, which rests on the end of the adjusting-screw O. These parts, with the glass cylinder F, are clamped to the flange B by means of four long screws P and the ring R; on the ring R screws the cap *S*, which covers the lower parts of the cistern, and supports at the end the adjusting-screw O. G, *i*, *j*, and *k*, are of boxwood; the other parts of brass or German silver. The

FIG. 13.

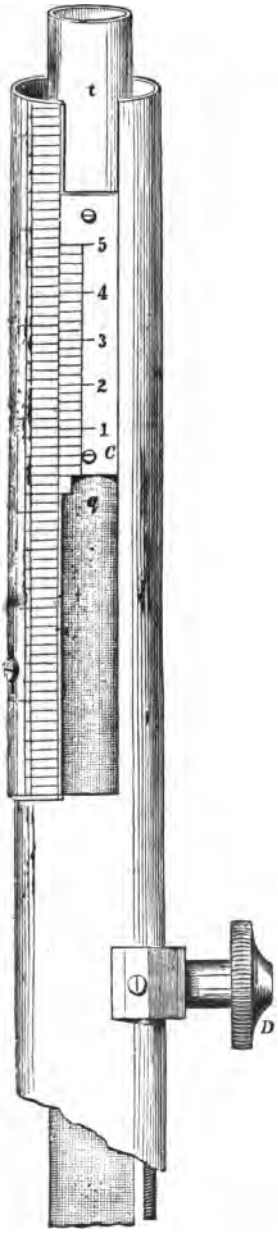
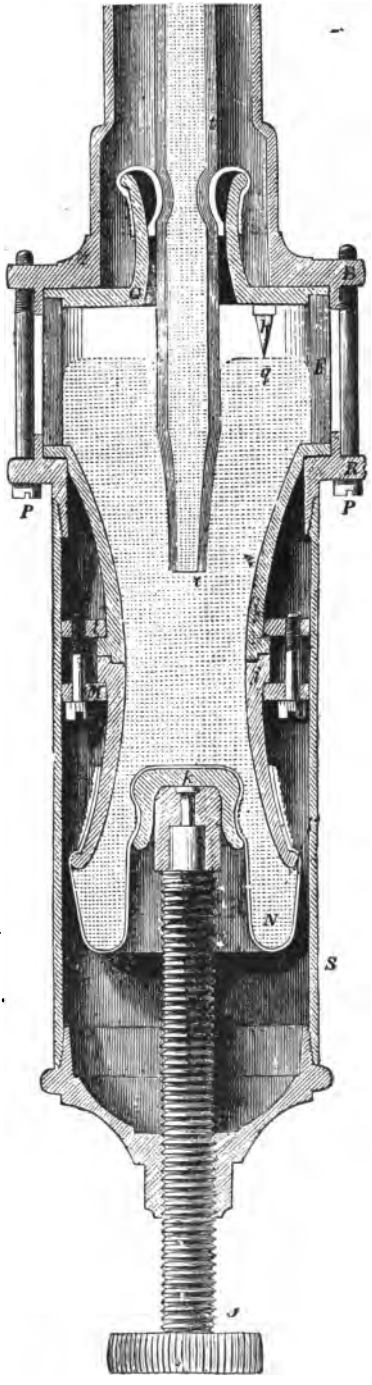


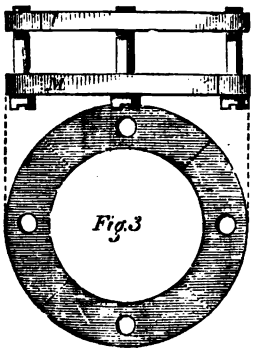
FIG. 12.



screw O serves to adjust the mercury to the ivory point, and also, by raising the bag, so as to completely fill the cistern and tube with mercury, to put the instrument in condition for transportation.

In Fortin's barometer, and also Delcro's modification of it, a cement is used to secure the mercury against leakage at the joints. This, sooner or later, is sure to give way; and tested under the extremes of the thermometrical and hygrometrical range of this climate especially, has made this defect more evident. This was removed by the substitution of iron in the place of wood; but it was soon found impracticable, in this form of cistern, to prevent damage from rust. These objections led to the present plan of construction, which effectually secures the joints without the use of any cement. The surfaces concerned are all made of a true figure, and simply clamped together by the screws, a very thin leather washer being interposed at the joints. This would not be permanent, however, but for the especial care taken in preparing the boxwood. The boxwood rings are all made from the centers of the wood, and concentric with its growth. They are worked thin and then toughened, as well as made impervious to moisture, by complete saturation with shellac. This is effected by immersing them in a suitable solution in vacuo. The air being withdrawn from the pores of the wood, is replaced by the lac. This, however, with the after-drying or baking, requires care; but when properly done, the wood is rendered all but unchangeable.

FIG. 14.



Another peculiarity consists in making the scale adjustable to correct for capillarity, so that the barometer may read exactly with the adopted standard without the application of any correction; and this, too, without destroying the character of the barometer as an original and standard instrument. Near the 30 inches line, Figure 6, is a line *v*, on the main tube; this last line is distant exactly 30 inches from the tip of the ivory point; therefore, when these lines coincide, or make one line, the scale is in true measurement position, or the 30 mark is exactly 30 inches from the tip of the ivory point in the cisrn. In this position, the amount of correction due to capillarity being ascertained, the scale is then moved that quantity and clamped firm. The barometer will now give the readings corrected for capillarity, and thus avoid at once the labor of applying a correction and the risk of error from an accidental neglect of it.

FIG. 15.

It must be borne in mind that this correction applies only to the particular tube, and while preserved in good condition.

If this tube is injured and again used, or another tube put in its place, the scale should then be moved until the lines coincide, the amount of correction for the repaired or the new tube being estimated until a good comparison can be made directly or intermediately with the standard.

The connecting of the parts *i* and *j* by rings and screws, Figs. 12 and 14, rather than by a single screw cut on the edge, is an improvement, as the single wood-screw is apt, after a time, to adhere so firmly that it is often difficult, and sometimes impossible, with safety to the parts, to separate it.

It is not advisable to disturb the cistern, unless it becomes difficult,

from the oxide of mercury which gradually forms, to make the adjustment of the mercury to the ivory point, as there is more or less risk in doing so. Any one accustomed to such mechanical affairs, with due attention to the plan, can, however, take out the mercury from the cistern, refilter, clear the parts of adhering oxide, and replace them; the instrument all the time being kept vertical, with the cistern at top, as the mercury must not be allowed to come from the tube.

To insure a good vacuum by the complete expulsion of all air and moisture, the boiling of the mercury in the tube is done in vacuo, and care should be taken to preserve it in good condition.

To put up the barometer for observation, suspend the barometer by the ring A in a good light, near to and at the left side of a window, and, when practicable, in a room not liable to sudden variations of temperature. Record the temperature, and then, by the screw O, lower the mercury in the cistern until the surface is in the same plane with the extremity of the ivory point. As this extremity of the point is the zero of the scale, it is necessary, at each observation, to perfect this adjustment. It is perfect when the mercury just makes visible contact. If the surface is lowered a little it is below the point, and if raised a small amount a distinct depression is seen around the point. This depression is reduced to the least visible degree. A few trials will show taht this adjustment can always be made to a thousandth of an inch.

Fig. 16.

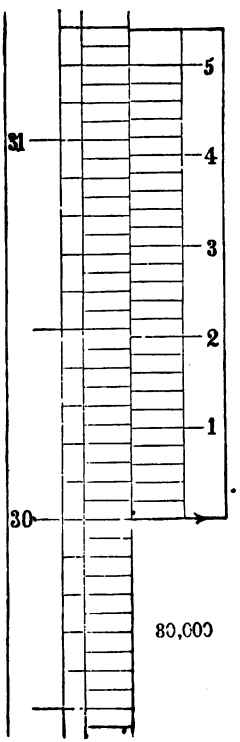
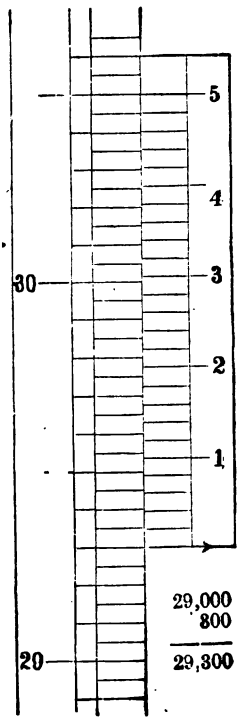


Fig. 17.



The adjustment effected, bring the lower edge of the vernier C, Fig. 13, by means of the milled head D, into the same plane with the convex summit of the mercury in the tube. Looking through the opening, with the the eye on a level with the top of the mercury in the tube, when the vernier tube is too low, the light is cut off; when too high, the light is seen above the top of the mercury. It is right when the light is just cut off from the summit, the edge making a tangent to the curve. A piece of white paper placed behind, and also at the cistern, will be found to give a more agreeable lightby day, and is, besides, necessary for night observations, the lamp being placed before the instrument and above the eye to reflect the light.

The method of reading off will perhaps be best explained by a few ex-

amples. Suppose, after completing the adjustments, the scale and vernier to be in the position shown in Fig. 16, it will be seen that the lowest or index line of the vernier coincides exactly with the line marked 30 on the scale. The reading, therefore, is 30.000 inches.

If, as in Fig. 17, we find the line of the vernier coinciding with the third line of the tenths above 29, we read 29.300.

If, as in Fig. 18, on this page, we find the index at 29 inches 3 tenths and 5 hundredths, we read 29.350.

If, as in Fig. 19, we find the index at 30 inches no tenths 5 hundredths and something more, this additional quantity we shall find by looking up the vernier scale, until we come to some one line on it coinciding with a line on the other scale. In this instance it is the line marked 2, and indicates 2 hundredths, to be added to the other numbers, making 30.070.

FIG. 18.

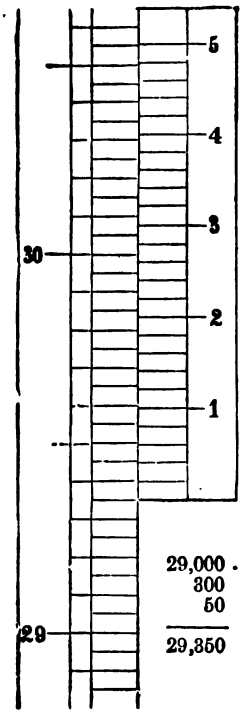
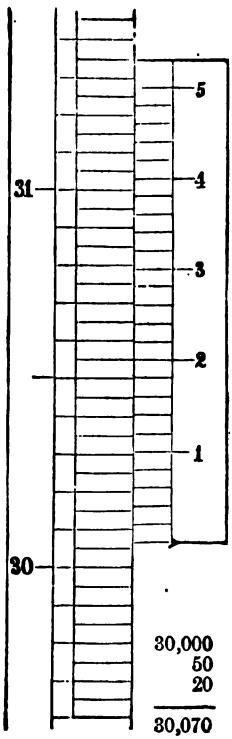


FIG. 19.



If, as in Fig. 20, we find 29 inches no tenths 5 hundredths, and on the vernier the second line above that marked 2 is found to coincide with the scale, each of these short lines indicates 2 thousandths—consequently, are so counted; the reading is therefore 29.074.

Or it may be, as in Fig. 21, where we have 30 inches 1 tenth, and the line on the vernier mark 3 coinciding nearly, but not perfectly, with a line on the scale, it is a little too high; the 2 thousandth short line next above is, however, a like quantity too low; so the true reading must be the number between them—that is, 1 thousandth, making together 30.131.

These examples include all the combinations the scale allows. A little practice with the barometer, with reference to the examples, will soon enable the learner to read off the scale with facility. At first it will be best to write down the inches and parts in full, as in the diagrams; not trusting the memory with the whole, until experience shall have given confidence.

Be careful never to lower the mercury in the cistern much below the necessary quantity, as it increases the risk of air entering the tube.

When the barometer is to be removed for transportation, or change of position, before taking it down, the mercury is to be screwed up until the tube is nearly full. If it is screwed more than this, the cistern bag is liable to be broken or the mercury may be forced through the joints of the cistern. It should then be carefully inverted, the screw slightly loosened, and carried cistern-end upwards.

FIG. 20.

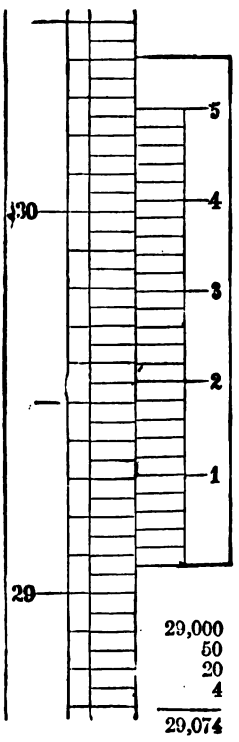
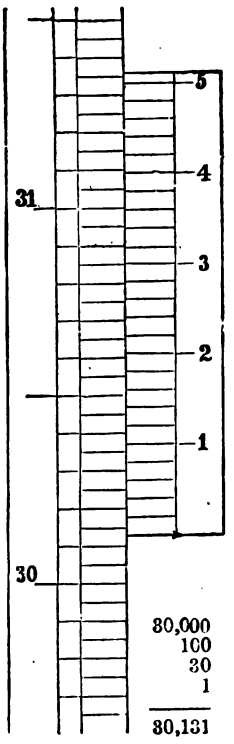


FIG. 21.



This instrument is well adapted for service as a mountain barometer, and when used as such, is packed in a leather case, with suitable straps for convenient carriage.

CORRECTION OF BAROMETRIC OBSERVATIONS.

Corrections must be applied to all barometer readings in order to bring the indications of different instruments into harmony with each

other before they can be used for scientific purposes. Some of these corrections have reference to the special instrument, while others are applied to the reading of any instrument taken under the same conditions. The corrections of the former class are two in number:

I. Instrumental error.
II. Capillarity.

Those of the latter class are also two:

III. Temperature.
IV. Altitude above sea-level.

I. Correction for instrumental error. This is applied according to the error discovered in the individual instrument when compared with the standard. It may be either additive (+) or subtractive (—).

II. Correction for capillarity. The indications of barometers are affected by the capillary action between the glass tube and the mercury, the effect of which is constantly to depress the mercury by a certain quantity nearly inversely proportional to the diameter of the tube.

The correction, therefore, is always additive.

This depression is greater in tubes in which the mercury has not been boiled than in those which have been subjected to this process.

The following table gives the corrections to be applied to English barometers. It takes into account the diameter of the tube, but not the variations of the height of the *meniscus*, *i. e.*, the convexity which terminates the column:

Diameter of tube.	Correction for—	
	Unboiled tubes.	Boiled tubes.
Inch.	*Inch.*	*Inch.*
0.60	0.004	0.002
0.50	0.007	0.003
0.45	0.010	0.005
0.40	0.014	0.007
0.35	0.020	0.010
0.30	0.028	0.014
0.25	0.040	0.020
0.20	0.060	0.029
0.15	0.088	0.044
0.10	0.142	0.070

The certificates furnished from Chief Signal Office for all barometers verified there, give the results of direct readings of the column at different heights, and so include the corrections above mentioned, in so far as any of them are applicable to the special barometer under consideration.

Correction for temperature, or reduction to 32° *F.*—All bodies are affected in their dimensions by heat; with few exceptions they expand when their temperature rises and contract when it falls, and it is therefore necessary, in taking any accurate measure of the length of any object, to know at what temperature the measure was made, in order that we may know what the length would have been at some definite temperature, which is taken as the standard temperature. In the case of barometers this standard temperature is 32°, and accordingly, speaking in general terms, when the barometer is at a temperature below 32° the

correction is additive (+), and when it is above 32° it is subtractive (—).

Table No. VII gives the corrections for barometers with brass scales, and it will be seen from it that the sign of the correction changes from + to — at the temperature of 29°.

The temperature of the barometer is given by the attached thermometer, the bulb of which is so placed as to give as accurately as possible possible the true temperature of the actual column of mercury.

The pressure is given in the table for each half inch from 24 to 31 inches, as of course the correction depends on the length of the column of which the temperature is given by the attached thermometer.

In consequence of the great risk of the heat of the observer's person affecting the thermometer attached to the instrument during the process of taking a reading of the barometer, the attached thermometer is always to be read first of all, before the reading of the barometrical column is made.

Correction for altitude or reduction to sea level.—As the barometer measures the pressure of the atmosphere, it is evident that if that pressure be increased or diminished, the length of the barometrical column will become greater or less. If we suppose the air to be homogeneous, and to rest on the surface of the earth as an outer shell of uniform thickness, it is evident that if we ascended a mountain there would be a less thickness of this shell of air above us, and therefore a less pressure, and *vice versa* if we went down a mine there would be a greater pressure.

Accordingly, as we have seen that the barometrical readings must be reduced to a standard temperature, to make them intercomparable, they must also be reduced to a standard level, and that is the mean level of the sea.

The problem of correction for altitude is, however, not so easy as would appear from what has just been said. For simplicity we shall deal only with heights *above* sea-level, as by far the most important to us. The difference in pressure for which the correction has to be applied is for the heights of the vertical column of air which would extend from the level of the station to that of the sea. But the weight of this column differs according to its temperature, being greater if the air is cold than if it is warm. We must, therefore, take into account the temperature of the air at the time, and give the corrections for every ten degrees, from —20° to 100°, which are about the limits within which barometrical observations are usually made. This temperature must be taken from the dry-bulb thermometer, not from that attached to the barometer.

We see, also, from the explanation of the table No. VIII, that as the formula enables us to find the proportion which the pressure of the atmosphere at the upper station bears to that at the sea-level, the correction will vary according to the amount of that pressure at the sea-level, so that two tables are given for the extreme limits of pressure which are likely to occur at the sea-level, viz, 30 and 27 inches, and the corrections for intermediate readings must be obtained by interpolation.

Specimens of the mode of correcting and reducing barometer readings are here subjoined.

If the barometer has a known correction, as this includes the corrections for instrumental error and capillarity, then proceed as follows:

			Inches
Barometer reading	29.946 inches.	Uncorrected reading	29.946
Attached thermometer	68 degrees.	Deduct temperature correction for 68 degrees and 30 inches	—.106
Standard correction for instrument	+.014 inch.	Reading at 32 degrees	29.840
		Add for standard correction	+.014
Temperature of air by dry bulb	50 degrees.	Barometer corrected for temperature and instrument error	29.854
Altitude of cistern above mean sea-level	105 feet.	Add for altitude of 105 feet at temperature of air, 50 degrees, and approximate pressure at sea-level, 30.00 inches	+.116
		Reading corrected and reduced to 32 degrees and sea-level	29.970

Table VIII. gives accurate reductions to sea-level for altitudes below 1,500 feet. Special tables for reducing barometric observations taken at altitudes above 1,500 feet may be computed by the formula on page —, or, when the altitude of station is known, a constant correction will be supplied upon application to the Chief Signal Officer.

EXPLANATION OF THE TABLES.

TABLE VII. contains the correction to be applied to the readings of barometers mounted in *brass* frames, in order to reduce them to the normal temperature, 32°. It has been computed from the following formula given by Schumacher—

$$\text{Correction} = -h\,\frac{m\,(t-32)-s\,(t-62)}{1+m\,(t-32)}$$

in which

h=reading of the barometer,

t=temperature of attached thermometer,

m=expansion of mercury for 1° F., taken as .0001001 of its length at 32°,

s=expansion of the substance of which the scale is made; for brass s is taken as .00001041 of its length (h) at the standard temperature for the scale, viz, 62° F.

TABLE VIII. is for reducing to the sea-level observations of the barometer made at any height not exceeding 1,500 feet. It is given for two pressures at the lower station, namely, 30 and 27 inches. For intermediate pressures, the correction may be obtained by proportional parts.

For heights exceeding those given in the Table, the value at the sea-level, of a barometer reading at a station, the height of which is known, may be calculated from the following formula:

$$\text{Log}\frac{h}{h'}=f\div\left\{60159\left(1+\frac{t+t'-64}{900}\right)\left(1+\cdot00268\cos 2\,l\right)\left(1+\frac{f+52251}{20886861}\right)\right\}$$

From a table of common logarithms, the natural number corresponding to $\log\frac{h}{h'}$ is found; or, $\frac{h}{h'}=n$,

And $h=n\,h'$.

In this formula—

h and h' = barometer reduced to 32° F., at the lower and upper stations respectively,

t and t' = the temperature of the air at the respective stations,

f = elevation of upper station in feet,

l = latitude of the place.

The above formula is merely an inversion of the well-known formula given by Laplace, in his *Mécanique Céleste*, for finding the difference of elevation between any two places by means of the barometer, which, adapted to Fahrenheit's thermometer, and English feet and inches, is—

$$f=60159 \log \frac{h}{h'}\left(1+\frac{t+t'-64}{900}\right)\left(1+.00268 \cos 2\,l\right)\left(1+\frac{f+52251}{20886861}+\frac{x}{10443430}\right)$$

In this formula f is the difference of elevation between the two stations, and x is the height of the lower station above the sea-level.

In the last factor an approximate value must be used for f.

TABLE VII.—Correction to be applied to barometers with *brass scales*, extending from the cistern to the top of the mercurial column, to reduce the observation to 32° Fahrenheit.

Temperature.	Inches.															Temperature.
	24.0.	24.5.	25.0.	25.5.	26.0.	26.5.	27.0.	27.5.	28.0.	28.5.	29.0.	29.5.	30.0.	30.5.	31.0.	
°	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	°
0	.061	.063	.064	.065	.067	.068	.069	.071	.072	.073	.074	.076	.077	.078	.080	0
1	.059	.061	.062	.063	.064	.065	.067	.068	.069	.071	.072	.073	.074	.076	.077	1
2	.057	.058	.060	.061	.062	.063	.064	.066	.067	.068	.069	.070	.072	.073	.074	2
3	.055	.056	.057	.059	.060	.061	.062	.063	.064	.065	.067	.068	.069	.070	.071	3
4	.053	.054	.055	.056	.057	.058	.059	.061	.062	.063	.064	.065	.066	.067	.068	4
5	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060	.061	.062	.063	.065	.066	5
6	.049	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060	.061	.062	.063	6
7	.046	.047	.048	.049	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060	7
8	.044	.045	.046	.047	.048	.049	.050	.051	.052	.053	.054	.054	.055	.056	.057	8
9	.042	.043	.044	.045	.046	.046	.047	.048	.049	.050	.051	.052	.053	.054	.054	9
10	.040	.041	.042	.042	.043	.044	.045	.046	.047	.047	.048	.049	.050	.051	.052	10
11	.038	.039	.039	.040	.041	.042	.042	.043	.044	.045	.046	.046	.047	.048	.049	11
12	.036	.036	.037	.038	.039	.039	.040	.041	.042	.042	.043	.044	.045	.045	.046	12
13	.033	.034	.035	.036	.036	.037	.038	.038	.039	.040	.040	.041	.042	.043	.043	13
14	.031	.032	.033	.033	.034	.035	.035	.036	.037	.037	.038	.038	.039	.040	.040	14
15	.029	.030	.030	.031	.032	.032	.033	.033	.034	.035	.035	.036	.036	.037	.038	15
16	.027	.028	.028	.029	.029	.030	.030	.031	.032	.032	.033	.033	.034	.034	.035	16
17	.025	.025	.026	.026	.027	.027	.028	.028	.029	.030	.030	.031	.031	.032	.032	17
18	.023	.023	.024	.024	.025	.025	.025	.026	.026	.027	.027	.028	.028	.029	.029	18
19	.021	.021	.021	.022	.022	.023	.023	.024	.024	.024	.025	.025	.026	.026	.027	19
20	.018	.019	.019	.020	.020	.020	.021	.021	.021	.022	.022	.023	.023	.023	.024	20
21	.016	.017	.017	.017	.018	.018	.018	.019	.019	.019	.020	.020	.020	.021	.021	21
22	.014	.014	.015	.015	.015	.016	.016	.016	.016	.017	.017	.017	.018	.018	.018	22
23	.012	.012	.012	.013	.013	.013	.013	.014	.014	.014	.014	.015	.015	.015	.015	23
24	.010	.010	.010	.010	.011	.011	.011	.011	.011	.012	.012	.012	.012	.012	.013	24
25	.008	.008	.008	.008	.008	.008	.009	.009	.009	.009	.009	.009	.009	.010	.010	25
26	.005	.006	.006	.006	.006	.006	.006	.006	.006	.006	.007	.007	.007	.007	.007	26
27	.003	.003	.003	.003	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	27
28	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	28
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
29	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	29
30	.003	.003	.003	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	.004	30
31	.005	.006	.006	.006	.006	.006	.006	.006	.006	.006	.007	.007	.007	.007	.007	31
32	.008	.008	.008	.008	.008	.008	.008	.009	.009	.009	.009	.009	.009	.010	.010	32
33	.010	.010	.010	.010	.011	.011	.011	.011	.011	.012	.012	.012	.012	.012	.012	33
34	.012	.012	.012	.013	.013	.013	.013	.014	.014	.014	.014	.015	.015	.015	.015	34
35	.014	.014	.015	.015	.015	.015	.016	.016	.016	.017	.017	.017	.018	.018	.018	35
36	.016	.017	.017	.017	.017	.018	.018	.019	.019	.019	.020	.020	.020	.021	.021	36
37	.018	.019	.019	.019	.020	.020	.021	.021	.021	.022	.022	.022	.023	.023	.024	37
38	.020	.021	.021	.022	.022	.023	.023	.023	.024	.024	.025	.025	.026	.026	.026	38
39	.023	.023	.024	.024	.024	.025	.525	.026	.026	.027	.027	.028	.028	.029	.029	39
40	.025	.025	.026	.026	.027	.027	.028	.028	.029	.029	.030	.030	.031	.031	.032	40
41	.027	.027	.028	.029	.029	.030	.030	.031	.031	.032	.033	.033	.034	.034	.035	41
42	.029	.030	.030	.031	.031	.032	.033	.033	.034	.034	.035	.036	.036	.037	.037	42
43	.031	.032	.032	.033	.034	.034	.035	.036	.036	.037	.038	.038	.039	.040	.040	43
44	.033	.034	.035	.035	.036	.037	.037	.038	.039	.040	.040	.041	.042	.042	.043	44
45	.035	.036	.037	.038	.038	.039	.040	.041	.041	.042	.043	.044	.044	.045	.046	45
46	.038	.038	.039	.040	.041	.042	.042	.043	.044	.045	.045	.046	.047	.048	.049	46
47	.040	.041	.041	.042	.043	.044	.045	.046	.046	.047	.048	.049	.050	.051	.051	47
48	.042	.043	.044	.045	.045	.046	.047	.048	.049	.050	.051	.052	.052	.053	.054	48
49	.044	.045	.046	.047	.048	.049	.050	.050	051	.052	.053	.054	.055	.056	.057	49
50	.046	.047	.048	.049	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060	50

TABLE VII.—Continued.

Temperature.	Inches.															Temperature.
	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0	30.5	31.0	
°	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	°
51	.048	.049	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060	.061	.062	51
52	.050	.052	.053	.054	.055	.056	.057	.058	.059	.060	.061	.062	.063	.064	.065	52
53	.053	.054	.055	.056	.057	.058	.059	.060	.061	.063	.064	.065	.066	.067	.068	53
54	.055	.056	.057	.058	.059	.060	.062	.063	.064	.065	.066	.067	.068	.070	.071	54
55	.057	.058	.059	.060	.062	.063	.064	.065	.066	.068	.069	.070	.071	.072	.073	55
56	.059	.060	.061	.063	.064	.065	.066	.068	.069	.070	.071	.073	.074	.075	.076	56
57	.061	.062	.064	.065	.066	.068	.069	.070	.071	.073	.074	.075	.076	.078	.079	57
58	.063	.065	.066	.067	.069	.070	.071	.073	.074	.075	.077	.078	.079	.081	.082	58
59	.065	.067	.068	.070	.071	.072	.074	.075	.076	.078	.079	.080	.082	.083	.085	59
60	.068	.069	.070	.072	.073	.075	.076	.077	.079	.080	.082	.083	.085	.086	.087	60
61	.070	.071	.073	.074	.075	.077	.078	.080	.081	.083	.084	.086	.087	.089	.090	61
62	.072	.073	.075	.076	.078	.079	.081	.082	.084	.085	.087	.088	.090	.091	.093	62
63	.074	.076	.077	.079	.080	.082	.083	.085	.086	.088	.089	.091	.093	.094	.096	63
64	.076	.078	.079	.081	.082	.084	.086	.087	.089	.090	.092	.094	.095	.097	.098	64
65	.078	.080	.082	.083	.085	.086	.088	.090	.091	.093	.095	.096	.098	.100	.101	65
66	.080	.082	.084	.085	.087	.089	.090	.092	.094	.096	.097	.099	.101	.102	.104	66
67	.083	.084	.086	.088	.089	.091	.093	.095	.096	.098	.100	.102	.103	.105	.107	67
68	.085	.086	.088	.090	.092	.094	.095	.097	.099	.101	.102	.104	.106	.108	.109	68
69	.087	.089	.090	.092	.094	.096	.098	.100	.101	.103	.105	.107	.109	.110	.112	69
70	.089	.091	.093	.095	.096	.098	.100	.102	.104	.106	.108	.109	.111	.113	.115	70
71	.091	.093	.095	.097	.099	.101	.102	.104	.106	.108	.110	.112	.114	.116	.118	71
72	.093	.095	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115	.117	.119	.120	72
73	.095	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115	.117	.119	.121	.123	73
74	.097	.099	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120	.122	.124	.126	74
75	.100	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120	.122	.125	.127	.129	75
76	.102	.104	.106	.108	.110	.112	.114	.117	.119	.121	.123	.125	.127	.129	.131	76
77	.104	.106	.108	.110	.112	.115	.117	.119	.121	.123	.126	.128	.130	.132	.134	77
78	.106	.108	.110	.113	.115	.117	.119	.122	.124	.126	.128	.130	.133	.135	.137	78
79	.108	.110	.113	.115	.117	.119	.122	.124	.126	.128	.131	.133	.135	.137	.140	79
80	.110	.113	.115	.117	.119	.122	.124	.126	.129	.131	.133	.136	.138	.140	.143	80
81	.112	.115	.117	.119	.122	.124	.126	.129	.131	.134	.136	.138	.141	.143	.145	81
82	.114	.117	.119	.122	.124	.126	.129	.131	.134	.136	.138	.141	.143	.146	.148	82
83	.117	.119	.121	.124	.126	.129	.131	.134	.136	.139	.141	.143	.146	.148	.151	83
84	.119	.121	.124	.126	.129	.131	.134	.136	.139	.141	.144	.146	.149	.151	.154	84
85	.121	.123	.126	.128	.131	.133	.136	.139	.141	.144	.146	.149	.151	.154	.156	85
86	.123	.126	.128	.131	.133	.136	.138	.141	.144	.146	.149	.151	.154	.156	.159	86
87	.125	.128	.130	.133	.136	.138	.141	.143	.146	.149	.151	.154	.157	.159	.162	87
88	.127	.130	.133	.135	.138	.141	.143	.146	.149	.151	.154	.157	.159	.162	.165	88
89	.129	.132	.135	.137	.140	.143	.146	.148	.151	.154	.156	.159	.162	.165	.167	89
90	.131	.134	.137	.140	.142	.145	.148	.151	.153	.156	.159	.162	.164	.167	.170	90
91	.134	.136	.139	.142	.145	.148	.150	.153	.156	.159	.162	.165	.167	.170	.173	91
92	.136	.139	.141	.144	.147	.150	.153	.156	.158	.161	.164	.167	.170	.172	.175	92
93	.138	.141	.144	.147	.149	.152	.155	.158	.161	.164	.167	.170	.172	.175	.178	93
94	.140	.143	.146	.149	.152	.155	.157	.161	.163	.166	.169	.172	.175	.177	.180	94
95	.142	.145	.148	.151	.154	.157	.160	.163	.166	.169	.172	.175	.178	.180	.185	95
96	.144	.147	.150	.153	.156	.159	.162	.165	.168	.171	.174	.178	.181	.183	.183	96
97	.146	.149	.152	.156	.159	.162	.165	.168	.171	.174	.177	.180	.183	.186	.189	97
98	.148	.152	.155	.158	.161	.164	.167	.170	.173	.176	.179	.183	.186	.188	.191	98
99	.151	.154	.157	.160	.163	.166	.169	.173	.176	.179	.182	.185	.188	.191	.194	99
100	.153	.156	.159	.162	.165	.169	.172	.175	.178	.181	.184	.188	.191	.194	.197	100

TABLE VIII.

Table for reducing observations of the barometer to sea-level, correction additive.

(Barometer reading at sea-level, 30 inches.)

Height in feet.	Temperature of external air—degrees Fahrenheit.													Height in feet.
	—20°	—10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	
10	.013	.013	.012	.012	.012	.012	.011	.011	.011	.011	.010	.010	.010	10
20	.026	.025	.025	.024	.023	.023	.023	.022	.022	.021	.021	.020	.020	20
30	.039	.038	.037	.036	.035	.034	.034	.033	.032	.032	.031	.030	.030	30
40	.052	.050	.049	.048	.047	.046	.045	.044	.043	.042	.041	.040	.040	40
50	.065	.063	.061	.060	.059	.058	.056	.055	.054	.053	.052	.051	.050	50
60	.077	.076	.074	.072	.070	.069	.068	.066	.065	.063	.062	.061	.059	60
70	.090	.088	.086	.084	.082	.081	.078	.077	.076	.074	.072	.071	.069	70
80	.103	.101	.098	.096	.094	.092	.090	.088	.086	.084	.082	.081	.079	80
90	.116	.113	.111	.108	.105	.104	.101	.099	.097	.095	.093	.091	.089	90
100	.129	.126	.123	.120	.117	.115	.112	.110	.108	.105	.103	.101	.099	100
110	.142	.139	.135	.132	.129	.126	.123	.121	.119	.116	.113	.111	.109	110
120	.155	.151	.148	.144	.140	.138	.134	.132	.129	.126	.124	.121	.119	120
130	.168	.164	.160	.156	.152	.149	.146	.143	.140	.137	.134	.131	.129	130
140	.181	.176	.172	.168	.164	.161	.157	.154	.151	.147	.144	.141	.139	140
150	.194	.189	.185	.180	.176	.172	.168	.165	.162	.158	.155	.152	149	150
160	.206	.201	.197	.192	.187	.183	.179	.176	.172	.168	.165	.162	.158	160
170	.219	.214	.209	.204	.199	.195	.190	.187	.183	.179	.175	.172	.168	170
180	.232	.227	.222	.216	.211	.206	.202	.198	.194	.189	.185	.182	.178	180
190	.245	.239	.234	.228	.222	.218	.213	.209	.204	.200	.196	.192	.188	190
200	.258	.252	.246	.240	.234	.229	.224	.220	.215	.210	.206	.202	.198	200
210	.271	.264	.258	.252	.246	.240	.235	.231	.226	.221	.216	.212	.208	210
220	.284	.277	.270	.264	.257	.252	.246	.242	.236	.231	.227	.222	.218	220
230	.296	.289	.283	.276	.269	.263	.257	.253	.247	.242	.237	.232	.228	230
240	.309	.302	.295	.288	.281	.275	.269	.264	.258	.252	.248	.242	.238	240
250	.322	.314	.307	.300	.293	.286	.280	.275	.269	.263	.258	.253	.248	250
260	.335	.327	.319	.311	.304	.297	.291	.285	.279	.273	.268	.263	.257	260
270	.348	.339	.331	.323	.316	.309	.302	296	.290	.284	.278	.273	.267	270
280	.360	.352	.344	.335	.328	.320	.314	.307	.301	.294	.288	.283	.277	280
290	.373	.364	.356	.347	.339	.332	325	.318	.311	.305	.299	.293	.287	290
300	.386	.377	.368	.359	.351	.343	.336	.329	.322	.315	.309	.303	.297	300
310	.399	.389	.380	.371	.363	.354	.347	.340	.333	.326	.319	.313	.307	310
320	.412	.402	.392	.383	.374	.366	.358	.351	.343	.336	.329	.323	.317	320
330	.424	.414	.404	.395	.386	.377	.369	.362	.354	.347	.340	.333	.326	330
340	.437	.427	.416	.407	.397	.389	.380	.373	.365	.357	.350	.343	.336	340
350	.450	.439	.429	.419	.409	.400	.392	.384	.376	.268	.360	.353	.346	350
360	.463	.451	.441	.430	.421	.411	.403	.394	.386	.378	.370	.363	.356	360
370	.476	.464	.453	.442	.432	.423	.414	.405	.397	.389	.380	.373	.366	370
380	.488	.476	.465	.454	.444	.434	.425	.416	.408	.399	.391	.383	.375	380
390	.501	.489	.477	.466	.455	.446	.436	.427	.418	.410	.401	.393	.385	390
400	.514	.501	.489	.478	.467	.457	.447	.438	.429	.420	.411	.403	.395	400
410	.527	.513	.501	.490	.479	.468	.458	.449	.440	.430	.421	.413	.405	410
420	.539	.526	.513	.502	.490	.480	.469	.460	.450	.441	.431	.423	.415	420
430	.552	.538	.525	.513	.502	.491	.480	.470	.461	.451	.442	.433	.425	430
440	.565	.551	.537	.525	.513	.502	.491	.481	.471	.462	.452	.443	.434	440
450	.578	.563	.550	.537	.525	.513	.503	.492	.482	.472	.462	.453	.444	450
460	.590	.575	.562	.549	.537	.525	.514	.503	.493	.482	.472	.463	.454	460
470	.603	.588	.574	.561	.548	.536	.525	.514	.503	.493	.482	.473	.464	470
480	.616	.600	.586	.572	.560	.547	.536	.524	.514	.503	.493	.488	.474	480
490	.628	.613	.598	.584	.571	.559	.547	.535	.524	.514	.503	.493	.483	490
500	.641	.625	.610	.596	.583	.570	.558	.546	.535	.524	.513	.503	.493	500

TABLE VIII—Continued.

[Barometer reading at sea-level, 27 inches.]

Height in feet.	Temperature of external air—degrees Fahrenheit.													Height in feet.
	—20°	—10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	
10	.012	.011	.011	.011	.011	.010	.010	.010	.010	.010	.009	.009	.009	10
20	.023	.023	.022	.022	.021	.021	.020	.020	.019	.019	.019	.018	.018	20
30	.035	.034	.033	.032	.032	.031	.030	.030	.029	.028	.028	.027	.027	30
40	.046	.046	.044	.043	.042	.041	.040	.040	.039	.038	.037	.036	.036	40
50	.058	.057	.056	.054	.053	.052	.051	.050	.049	.048	.047	.046	.045	50
60	.070	.068	.067	.065	.064	.062	.061	.059	.058	.057	.056	.055	.053	60
70	.081	.080	.078	.076	.074	.072	.071	.069	.068	.066	.065	.064	.062	70
80	.093	.091	.089	.086	.085	.082	.081	.079	.078	.076	.074	.073	.071	80
90	.104	.103	.100	.097	.095	.093	.091	.089	.087	.085	.084	.082	.080	90
100	.116	.114	.111	.108	.106	.103	.101	.099	.097	.095	.093	.091	.089	100
110	.128	.125	.122	.119	.116	.113	.111	.109	.107	.104	.102	.100	.098	110
120	.139	.137	.133	.130	.127	.124	.121	.119	.116	.114	.112	.109	.107	120
130	.151	.148	.144	.140	.137	.134	.131	.129	.126	.123	.121	.118	.116	130
140	.162	.159	.155	.151	.148	.144	.141	.139	.136	.133	.130	.127	.125	140
150	.174	.170	.166	.162	.158	.155	.152	.149	.146	.142	.139	.136	.134	150
160	.186	.182	.177	.173	.169	.165	.162	.158	.155	.152	.149	.146	.143	160
170	.197	.193	.188	.184	.179	.175	.172	.168	.165	.161	.158	.155	.152	170
180	.209	.204	.199	.194	.190	.185	.182	.178	.175	.171	.167	.164	.161	180
190	.220	.216	.210	.205	.200	.196	.192	.188	.184	.180	.177	.173	.170	190
200	.232	.227	.221	.216	.211	.206	.202	.198	.194	.190	.186	.182	.178	200
210	.244	.238	.232	.227	.221	.216	.212	.208	.204	.199	.195	.191	.187	210
220	.255	.249	.243	.237	.232	.227	.222	.218	.213	.209	.204	.200	.196	220
230	.267	.261	.254	.248	.242	.237	.232	.227	.223	.218	.214	.209	.205	230
240	.278	.272	.265	.259	.253	.247	.242	.237	.232	.228	.223	.218	.214	240
250	.290	.283	.276	.270	.263	.258	.252	.247	.242	.237	.232	.227	.223	250
260	.301	.294	.287	.280	.274	.268	.262	.257	.252	.246	.241	.236	.231	260
270	.313	.305	.298	.291	.284	.278	.272	.267	.261	.256	.250	.245	.240	270
280	.324	.317	.309	.302	.295	.288	.282	.276	.271	.265	.260	.254	.249	280
290	.336	.328	.320	.312	.305	.299	.292	.286	.280	.275	.269	.263	.258	290
300	.347	.339	.331	.323	.316	.309	.302	.296	.290	.284	.278	.272	.267	300
310	.359	.350	.342	.334	.326	.319	.312	.306	.300	.293	.287	.281	.276	310
320	.370	.361	.353	.344	.337	.329	.322	.316	.309	.303	.296	.290	.285	320
330	.382	.373	.364	.355	.347	.340	.332	.325	.319	.312	.306	.299	.294	330
340	.393	.384	.375	.366	.358	.350	.342	.335	.328	.322	.315	.308	.303	340
350	.405	.395	.386	.377	.368	.360	.352	.345	.338	.331	.324	.318	.312	350
360	.416	.406	.396	.387	.378	.370	.362	.355	.348	.340	.333	.327	.320	360
370	.428	.417	.407	.398	.389	.380	.372	.365	.357	.350	.342	.336	.329	370
380	.439	.429	.418	.409	.399	.391	.382	.374	.367	.359	.352	.345	.338	380
390	.451	.440	.429	.419	.410	.401	.392	.384	.376	.369	.361	.354	.347	390
400	.462	.451	.440	.430	.420	.411	.402	.394	.386	.378	.370	.363	.356	400
410	.473	.462	.451	.441	.430	.421	.412	.404	.395	.387	.379	.372	.365	410
420	.485	.473	.462	.451	.441	.431	.422	.413	.405	.397	.388	.381	.374	420
430	.496	.485	.473	.462	.451	.442	.432	.423	.414	.406	.398	.390	.382	430
440	.508	.496	.484	.472	.462	.452	.442	.433	.424	.415	.407	.399	.391	440
450	.519	.507	.495	.483	.472	.462	.452	.442	.433	.424	.416	.408	.400	450
460	.530	.518	.505	.494	.482	.472	.462	.452	.443	.434	.425	.417	.409	460
470	.542	.529	.516	.504	.493	.482	.472	.462	.452	.443	.434	.426	.418	470
480	.553	.541	.527	.515	.503	.493	.482	.472	.462	.452	.444	.435	.426	480
490	.565	.552	.538	.525	.514	.503	.492	.481	.471	.462	.453	.444	.435	490
500	.576	.563	.549	.536	.524	.513	.502	.491	.481	.471	.462	.453	.444	500

TABLE VIII—Continued.

(Barome sea-level, 30 inches.)

Height in feet.	Temperature of external air—degrees Fahrenheit.													Height in feet.
	—20°	—10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	
510	.654	.637	.622	.608	.594	.581	.569	.557	.545	.534	.523	.513	.503	510
520	.666	.650	.634	.620	.606	.593	.580	.568	.556	.545	.533	.523	.513	520
530	.679	.662	.646	.631	.617	.604	.591	.578	.566	.555	.544	.533	.522	530
540	.691	.675	.658	.643	.629	.615	.602	.589	.577	.565	.554	.543	.532	540
550	.704	.687	.670	.655	.640	.626	.613	.600	.587	.575	.564	.553	.542	550
560	.717	.699	.683	.667	.652	.638	.624	.611	.598	.586	.574	.563	.552	560
570	.729	.712	.695	.679	.663	.649	.635	.622	.608	.596	.584	.573	.562	570
580	.742	.724	.707	.690	.675	.660	.646	.632	.619	.606	.595	.583	.571	580
590	.754	.737	.719	.702	.686	.672	.657	.643	.629	.617	.605	.593	.581	590
600	.767	.749	.731	.714	.698	.683	.668	.654	.640	.627	.615	.603	.591	600
610	.780	.761	.743	.726	.709	.694	.679	.665	.650	.637	.625	.613	.601	610
620	.792	.774	.755	.738	.721	.705	.690	.675	.661	.648	.635	.623	.611	620
630	.805	.786	.767	.749	.732	.717	.701	.686	.671	.658	.645	.633	.620	630
640	.817	.798	.779	.761	.744	.728	.712	.697	.682	.668	.655	.643	.630	640
650	.830	.811	.791	.773	.755	.739	.723	.708	.692	.679	.666	.653	.640	650
660	.843	.823	.803	.785	.767	.750	.734	.718	.703	.689	.676	.662	.650	660
670	.855	.835	.815	.797	.778	.761	.745	.729	.713	.699	.686	.672	.660	670
680	.868	.847	.827	.808	.790	.773	.756	.740	.724	.709	.696	.682	.669	680
690	.880	.860	.839	.820	.801	.784	.767	.750	.734	.720	.706	.692	.679	690
700	.893	.872	.851	.832	.813	.795	.778	.761	.745	.730	.716	.702	.689	700
710	.905	.884	.863	.844	.824	.806	.789	.772	.755	.740	.726	.712	.698	710
720	.918	.896	.875	.855	.836	.817	.800	.782	.766	.751	.736	.722	.708	720
730	.930	.909	.887	.867	.847	.829	.811	.793	.776	.761	.746	.732	.718	730
740	.943	.921	.899	.879	.859	.840	.822	.804	.787	.771	.756	.742	.728	740
750	.955	.933	.911	.891	.870	.851	.833	.815	.797	.782	.767	.752	.738	750
760	.968	.945	.922	.902	.881	.862	.843	.825	.808	.792	.777	.761	.747	760
770	.980	.957	.934	.914	.893	.873	.854	.836	.818	.802	.787	.771	.757	770
780	.993	.970	.946	.926	.904	.885	.865	.847	.829	.812	.797	.781	.767	780
790	1.005	.982	.958	.937	.916	.896	.876	.857	.839	.823	.807	.791	.776	790
800	1.018	.994	.970	.949	.927	.907	.887	.868	.850	.833	.817	.801	.786	800
810	1.030	1.006	.982	.961	.938	.918	.898	.878	.860	.843	.827	.811	.796	810
820	1.043	1.018	.994	.972	.950	.929	.909	.889	.871	.854	.837	.821	.805	820
830	1.055	1.031	1.006	.984	.961	.940	.920	.900	.881	.864	.847	.831	.815	830
840	1.068	1.043	1.018	.995	.973	.951	.931	.911	.892	.874	.857	.841	.825	840
850	1.080	1.055	1.030	1.007	.984	.962	.942	.922	.902	.885	.867	.851	.835	850
860	1.093	1.067	1.041	1.019	.995	.974	.952	.932	.913	.895	.877	.860	.844	860
870	1.105	1.079	1.053	1.030	1.007	.985	.963	.943	.923	.905	.887	.870	.854	870
880	1.118	1.092	1.065	1.042	1.018	.996	.974	.954	.934	.915	.897	.880	.864	880
890	1.130	1.104	1.077	1.053	1.030	1.007	.985	.964	.944	.926	.907	.890	.873	890
900	1.143	1.116	1.089	1.065	1.041	1.018	.996	.975	.955	.936	.917	.900	.883	900
910	1.155	1.128	1.101	1.077	1.052	1.029	1.007	.986	.965	.946	.927	.910	.893	910
920	1.168	1.140	1.113	1.088	1.064	1.040	1.018	.996	.976	.956	.937	.920	.902	920
930	1.180	1.152	1.125	1.100	1.075	1.051	1.029	1.007	.986	.967	.947	.929	.912	930
940	1.193	1.164	1.137	1.111	1.086	1.062	1.040	1.017	.997	.977	.957	.939	.921	940
950	1.205	1.177	1.149	1.123	1.098	1.074	1.051	1.028	1.007	.987	.967	.949	.931	950
960	1.217	1.189	1.160	1.135	1.109	1.085	1.061	1.039	1.017	.997	.977	.959	.941	960
970	1.230	1.201	1.172	1.146	1.120	1.096	1.072	1.049	1.028	1.007	.987	.969	.950	970
980	1.242	1.213	1.184	1.158	1.131	1.107	1.083	1.060	1.038	1.018	.997	.978	.960	980
990	1.255	1.225	1.196	1.169	1.143	1.118	1.094	1.070	1.049	1.028	1.007	.988	.969	990
1,000	1.267	1.237	1.208	1.181	1.154	1.129	1.105	1.081	1.059	1.038	1.017	.998	.979	1,000

TABLE VIII—Continued.

(Barometer at sea-level, 27 inches.)

Height in feet.	Temperature of external air—degrees Fahrenheit.													Height in feet.
	—20°	—10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	
510	.587	.574	.560	.547	.534	.523	.512	.501	.490	.480	.471	.462	.453	510
520	.599	.585	.571	.557	.545	.533	.522	.510	.500	.490	.480	.471	.462	520
530	.610	.596	.582	.568	.555	.543	.532	.520	.509	.499	.489	.480	.470	530
540	.622	.607	.593	.578	.566	.553	.542	.530	.519	.508	.498	.489	.479	540
550	.633	.619	.604	.589	.576	.564	.552	.540	.528	.518	.508	.498	.488	550
560	.644	.630	.614	.600	.586	.574	.561	.549	.538	.527	.517	.506	.497	560
570	.656	.641	.625	.610	.597	.584	.571	.559	.547	.536	.526	.515	.506	570
580	.667	.652	.636	.621	.607	.594	.581	.569	.557	.545	.535	.524	.514	580
590	.679	.663	.647	.631	.618	.604	.591	.578	.566	.555	.544	.533	.523	590
600	.690	.674	.658	.642	.628	.614	.601	.588	.576	.564	.553	.542	.532	600
610	.701	.685	.669	.653	.638	.624	.611	.598	.585	.573	.562	.551	.541	610
620	.713	.696	.680	.663	.649	.634	.621	.607	.595	.583	.571	.560	.550	620
630	.724	.707	.690	.674	.659	.644	.631	.617	.604	.592	.580	.569	.558	630
640	.736	.718	.701	.684	.669	.654	.641	.627	.614	.601	.589	.578	.567	640
650	.747	.730	.712	.695	.680	.665	.651	.637	.623	.611	.599	.587	.576	650
660	.758	.741	.723	.706	.690	.675	.660	.646	.633	.620	.608	.596	.585	660
670	.770	.752	.734	.716	.700	.685	.670	.656	.642	.629	.617	.605	.594	670
680	.781	.763	.744	.727	.710	.695	.680	.666	.652	.638	.626	.614	.602	680
690	.793	.774	.755	.737	.721	.705	.690	.675	.661	.648	.635	.623	.611	690
700	.804	.785	.766	.748	.731	.715	.700	.685	.671	.657	.644	.632	.620	700
710	.815	.796	.777	.758	.741	.725	.710	.695	.680	.666	.653	.641	.629	710
720	.827	.807	.787	.769	.752	.735	.720	.704	.690	.676	.662	.650	.637	720
730	.838	.818	.798	.777	.762	.745	.729	.714	.699	.685	.671	.659	.646	730
740	.849	.829	.809	.790	.772	.755	.739	.723	.709	.694	.680	.668	.655	740
750	.861	.840	.820	.800	.783	.766	.749	.733	.718	.704	.690	.677	.664	750
760	.872	.851	.830	.811	.793	.776	.759	.743	.727	.713	.699	.685	.672	760
770	.883	.862	.841	.821	.803	.786	.769	.752	.737	.722	.708	.694	.681	770
780	.894	.873	.852	.832	.813	.796	.778	.762	.746	.731	.717	.703	.690	780
790	.906	.884	.862	.842	.824	.806	.788	.771	.756	.741	.726	.712	.698	790
800	.917	.895	.873	.853	.834	.816	.798	.781	.765	.750	.735	.721	.707	800
810	.928	.906	.884	.863	.844	.826	.808	.791	.774	.759	.744	.730	.716	810
820	.939	.917	.894	.874	.855	.836	.818	.800	.784	.768	.753	.739	.724	820
830	.951	.928	.905	.884	.865	.846	.827	.810	.793	.778	.762	.747	.733	830
840	.962	.939	.916	.895	.875	.856	.837	.819	.803	.787	.771	.756	.742	840
850	.973	.950	.927	.905	.886	.866	.847	.829	.812	.796	.780	.765	.751	850
860	.984	.960	.937	.916	.896	.876	.857	.839	.821	.805	.789	.774	.759	860
870	.995	.971	.948	.926	.906	.886	.867	.848	.831	.814	.798	.783	.768	870
880	1.007	.982	.959	.937	.916	.896	.876	.859	.840	.824	.807	.791	.777	880
890	1.018	.993	.969	.947	.927	.906	.886	.867	.850	.833	.816	.800	.785	890
900	1.029	1.004	.980	.958	.937	.916	.896	.877	.859	.842	.825	.809	.794	900
910	1.040	1.015	.991	.968	.947	.926	.906	.887	.868	.851	.834	.818	.803	910
920	1.051	1.026	1.001	.979	.957	.936	.916	.896	.878	.860	.843	.827	.811	920
930	1.063	1.037	1.012	.989	.968	.946	.925	.906	.887	.870	.852	.836	.820	930
940	1.074	1.048	1.023	1.000	.978	.956	.935	.915	.897	.879	.861	.845	.829	940
950	1.085	1.059	1.034	1.010	.988	.966	.945	.925	.906	.888	.870	.854	.838	950
960	1.096	1.069	1.044	1.020	.998	.976	.955	.935	.915	.897	.879	.862	.846	960
970	1.107	1.080	1.055	1.031	1.008	.986	.965	.944	.925	.906	.888	.871	.855	970
980	1.119	1.091	1.066	1.041	1.019	.996	.974	.954	.934	.916	.897	.880	.864	980
990	1.130	1.102	1.076	1.052	1.029	1.006	.984	.963	.944	.925	.906	.889	.872	990
1,000	1.141	1.113	1.087	1.062	1.039	1.016	.994	.973	.953	.934	.915	.898	.881	1,000

TABLE VIII—Continued.

(Barometer at sea-level, 30 inches.)

Height in feet.	Temperature of external air—Degrees Fahrenheit.													Height in feet.
	—20°	—10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	
1,010	1.279	1.249	1.220	1.192	1.165	1.140	1.116	1.092	1.069	1.048	1.027	1.008	0.989	1,010
1,020	1.292	1.261	1.232	1.204	1.177	1.151	1.127	1.102	1.080	1.058	1.037	1.018	0.998	1,020
1,030	1.304	1.273	1.243	1.215	1.188	1.162	1.137	1.113	1.090	1.069	1.047	1.027	1.008	1,030
1,040	1.317	1.285	1.255	1.227	1.199	1.173	1.148	1.123	1.101	1.079	1.057	1.037	1.017	1,040
1,050	1.329	1.298	1.267	1.238	1.211	1.184	1.159	1.134	1.111	1.089	1.067	1.047	1.027	1,050
1,060	1.341	1.310	1.279	1.250	1.222	1.195	1.170	1.145	1.121	1.099	1.077	1.057	1.037	1,060
1,070	1.354	1.322	1.291	1.261	1.233	1.206	1.181	1.155	1.132	1.109	1.087	1.067	1.046	1,070
1,080	1.366	1.334	1.302	1.273	1.244	1.217	1.191	1.166	1.142	1.120	1.097	1.076	1.056	1,080
1,090	1.379	1.346	1.314	1.284	1.256	1.228	1.202	1.176	1.153	1.130	1.107	1.086	1.065	1,090
1,100	1.391	1.358	1.326	1.296	1.267	1.239	1.213	1.187	1.163	1.140	1.117	1.096	1.075	1,100
1,110	1.403	1.370	1.338	1.307	1.278	1.250	1.224	1.198	1.173	1.150	1.127	1.106	1.085	1,110
1,120	1.416	1.382	1.350	1.319	1.289	1.261	1.235	1.208	1.184	1.160	1.137	1.115	1.094	1,120
1,130	1.428	1.394	1.361	1.330	1.301	1.272	1.245	1.219	1.194	1.170	1.147	1.125	1.104	1,130
1,140	1.440	1.406	1.373	1.342	1.312	1.283	1.256	1.229	1.204	1.180	1.157	1.135	1.113	1,140
1,150	1.453	1.418	1.385	1.353	1.323	1.294	1.267	1.240	1.215	1.191	1.167	1.145	1.123	1,150
1,160	1.465	1.430	1.397	1.365	1.334	1.305	1.278	1.251	1.225	1.201	1.177	1.154	1.133	1,160
1,170	1.477	1.442	1.409	1.376	1.345	1.316	1.289	1.261	1.235	1.211	1.187	1.164	1.142	1,170
1,180	1.489	1.454	1.420	1.388	1.357	1.327	1.299	1.272	1.245	1.221	1.197	1.174	1.152	1,180
1,190	1.502	1.466	1.432	1.399	1.368	1.338	1.310	1.282	1.256	1.231	1.207	1.183	1.161	1,190
1,200	1.514	1.478	1.444	1.411	1.379	1.349	1.321	1.293	1.266	1.241	1.217	1.193	1.171	1,200
1,210	1.526	1.490	1.456	1.422	1.390	1.360	1.332	1.303	1.276	1.251	1.227	1.203	1.180	1,210
1,220	1.539	1.502	1.467	1.434	1.401	1.371	1.342	1.314	1.287	1.261	1.237	1.212	1.190	1,220
1,230	1.551	1.514	1.479	1.445	1.413	1.382	1.353	1.324	1.297	1.271	1.247	1.222	1.199	1,230
1,240	1.563	1.526	1.491	1.457	1.424	1.393	1.364	1.335	1.307	1.281	1.257	1.232	1.209	1,240
1,250	1.576	1.538	1.502	1.468	1.435	1.404	1.374	1.345	1.317	1.291	1.266	1.242	1.218	1,250
1,260	1.588	1.550	1.514	1.479	1.446	1.415	1.385	1.356	1.328	1.302	1.276	1.251	1.228	1,260
1,270	1.600	1.562	1.526	1.491	1.457	1.426	1.396	1.366	1.338	1.312	1.286	1.261	1.237	1,270
1,280	1.612	1.574	1.538	1.502	1.469	1.437	1.407	1.377	1.348	1.322	1.296	1.271	1.247	1,280
1,290	1.625	1.586	1.549	1.514	1.480	1.448	1.417	1.387	1.359	1.332	1.306	1.280	1.256	1,290
1,300	1.637	1.598	1.561	1.525	1.491	1.459	1.428	1.398	1.369	1.342	1.316	1.290	1.266	1,300
1,310	1.649	1.610	1.573	1.536	1.502	1.470	1.439	1.408	1.379	1.352	1.326	1.300	1.275	1,310
1,320	1.661	1.622	1.584	1.548	1.513	1.481	1.449	1.419	1.390	1.362	1.336	1.309	1.285	1,320
1,330	1.674	1.634	1.596	1.559	1.525	1.492	1.460	1.429	1.400	1.372	1.346	1.319	1.294	1,330
1,340	1.686	1.646	1.608	1.571	1.536	1.503	1.471	1.440	1.410	1.382	1.356	1.329	1.304	1,340
1,350	1.698	1.658	1.620	1.582	1.547	1.514	1.482	1.450	1.420	1.393	1.366	1.339	1.313	1,350
1,360	1.710	1.669	1.631	1.593	1.558	1.524	1.492	1.461	1.431	1.403	1.375	1.348	1.323	1,360
1,370	1.722	1.681	1.643	1.605	1.569	1.535	1.503	1.471	1.441	1.413	1.385	1.358	1.332	1,370
1,380	1.735	1.693	1.655	1.616	1.581	1.546	1.514	1.482	1.451	1.423	1.395	1.368	1.342	1,380
1,390	1.747	1.705	1.666	1.628	1.592	1.557	1.524	1.492	1.462	1.433	1.405	1.377	1.351	1,390
1,400	1.759	1.717	1.678	1.639	1.603	1.568	1.535	1.503	1.472	1.443	1.415	1.387	1.361	1,400
1,410	1.771	1.729	1.690	1.650	1.614	1.579	1.546	1.513	1.482	1.453	1.425	.397	1.370	1,410
1,420	1.783	1.741	1.701	1.662	1.625	1.590	1.556	1.524	1.492	1.463	1.435	.406	1.380	1,420
1,430	1.796	1.753	1.713	1.673	1.636	1.601	1.567	1.534	1.503	1.473	1.444	1.416	1.389	1,430
1,440	1.808	1.765	1.724	1.685	1.647	1.612	1.577	1.545	1.513	1.483	1.454	1.426	1.399	1,440
1,450	1.820	1.777	1.736	1.696	1.658	1.623	1.588	1.555	1.523	1.493	1.464	1.436	1.408	1,450
1,460	1.832	1.788	1.748	1.707	1.670	1.633	1.599	1.565	1.533	1.503	1.474	1.445	1.418	1,460
1,470	1.844	1.800	1.759	1.719	1.681	1.644	1.609	1.576	1.543	1.513	1.484	1.455	1.427	1,470
1,480	1.857	1.812	1.771	1.730	1.692	1.655	1.620	1.586	1.554	1.523	1.493	1.465	1.437	1,480
1,490	1.869	1.824	1.782	1.742	1.703	1.666	1.630	1.597	1.564	1.533	1.503	1.474	1.446	1,490
1,500	1.881	1.836	1.794	1.753	1.714	1.677	1.641	1.607	1.574	1.543	1.513	1.484	1.456	1,500

TABLE VIII—Continued.

(Barometer at sea-level, 27 inches.)

Height in feet.	Temperature of external air—degrees Fahrenheit.													Height in feet.
	—20°	—10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	
1,010	1.152	1.124	1.098	1.072	1.049	1.026	1.004	0.983	0.962	0.943	0.924	0.907	0.890	1,010
1,020	1.163	1.135	1.108	1.083	1.059	1.036	1.013	0.992	0.972	0.952	0.933	0.916	0.898	1,020
1,030	1.174	1.146	1.119	1.093	1.069	1.046	1.023	1.002	0.981	0.962	0.942	0.924	0.907	1,030
1,040	1.185	1.157	1.129	1.104	1.079	1.056	1.033	1.011	0.991	0.971	0.951	0.933	0.915	1,040
1,050	1.196	1.168	1.140	1.114	1.090	1.066	1.043	1.021	1.000	0.980	0.960	0.942	0.924	1,050
1,060	1.208	1.178	1.151	1.124	1.100	1.075	1.052	1.031	1.009	0.989	0.969	0.951	0.933	1,060
1,070	1.219	1.189	1.161	1.135	1.110	1.085	1.062	1.040	1.019	0.998	0.978	0.960	0.941	1,070
1,080	1.230	1.200	1.172	1.145	1.120	1.095	1.072	1.050	1.028	1.008	0.987	0.968	0.950	1,080
1,090	1.241	1.211	1.182	1.156	1.130	1.105	1.082	1.059	1.038	1.017	0.996	0.977	0.958	1,090
1,100	1.252	1.222	1.193	1.166	1.140	1.115	1.091	1.069	1.047	1.026	1.005	0.986	0.967	1,100
1,110	1.263	1.233	1.204	1.176	1.150	1.125	1.101	1.078	1.056	1.035	1.014	0.995	0.976	1,110
1,120	1.274	1.244	1.214	1.187	1.160	1.135	1.110	1.088	1.066	1.044	1.023	1.004	0.984	1,120
1,130	1.285	1.254	1.225	1.197	1.170	1.145	1.120	1.097	1.075	1.053	1.032	1.012	0.993	1,130
1,140	1.296	1.265	1.235	1.208	1.180	1.155	1.130	1.107	1.084	1.062	1.041	1.021	1.001	1,140
1,150	1.307	1.276	1.246	1.218	1.190	1.164	1.140	1.116	1.094	1.072	1.050	1.030	1.010	1,150
1,160	1.319	1.287	1.257	1.228	1.201	1.174	1.149	1.126	1.103	1.081	1.059	1.039	1.019	1,160
1,170	1.330	1.298	1.267	1.239	1.211	1.184	1.159	1.135	1.112	1.090	1.068	1.048	1.027	1,170
1,180	1.341	1.308	1.278	1.249	1.221	1.194	1.169	1.145	1.121	1.099	1.077	1.056	1.036	1,180
1,190	1.352	1.319	1.288	1.260	1.231	1.204	1.178	1.154	1.131	1.108	1.086	1.065	1.044	1,190
1,200	1.363	1.330	1.299	1.270	1.241	1.214	1.188	1.164	1.140	1.117	1.095	1.074	1.053	1,200
1,210	1.374	1.341	1.310	1.280	1.251	1.224	1.198	1.173	1.149	1.126	1.104	1.083	1.062	1,210
1,220	1.385	1.352	1.320	1.291	1.261	1.234	1.207	1.183	1.159	1.135	1.113	1.091	1.070	1,220
1,230	1.396	1.362	1.331	1.301	1.271	1.244	1.217	1.192	1.168	1.144	1.122	1.100	1.079	1,230
1,240	1.407	1.373	1.341	1.311	1.281	1.254	1.227	1.202	1.177	1.153	1.131	1.109	1.087	1,240
1,250	1.418	1.384	1.352	1.322	1.292	1.263	1.237	1.211	1.187	1.163	1.140	1.118	1.096	1,250
1,260	1.429	1.395	1.363	1.332	1.302	1.273	1.246	1.220	1.196	1.172	1.148	1.126	1.105	1,260
1,270	1.440	1.406	1.373	1.342	1.312	1.283	1.256	1.230	1.205	1.181	1.157	1.135	1.113	1,270
1,280	1.451	1.416	1.384	1.352	1.322	1.293	1.266	1.239	1.214	1.190	1.166	1.144	1.122	1,280
1,290	1.462	1.427	1.394	1.363	1.332	1.303	1.275	1.249	1.224	1.199	1.175	1.152	1.130	1,290
1,300	1.473	1.438	1.405	1.373	1.342	1.313	1.285	1.258	1.233	1.208	1.184	1.161	1.139	1,300
1,310	1.484	1.449	1.415	1.383	1.352	1.323	1.295	1.267	1.242	1.217	1.193	1.170	1.148	1,310
1,320	1.495	1.460	1.426	1.394	1.362	1.333	1.304	1.277	1.251	1.226	1.202	1.178	1.156	1,320
1,330	1.506	1.470	1.436	1.404	1.372	1.342	1.314	1.286	1.261	1.235	1.211	1.187	1.165	1,330
1,340	1.517	1.481	1.447	1.414	1.382	1.352	1.323	1.296	1.270	1.244	1.220	1.196	1.173	1,340
1,350	1.528	1.492	1.457	1.425	1.393	1.362	1.333	1.305	1.279	1.254	1.229	1.204	1.182	1,350
1,360	1.539	1.503	1.468	1.435	1.403	1.372	1.343	1.314	1.288	1.263	1.237	1.213	1.191	1,360
1,370	1.550	1.514	1.478	1.445	1.413	1.382	1.352	1.324	1.297	1.272	1.246	1.222	1.199	1,370
1,380	1.561	1.524	1.489	1.455	1.423	1.391	1.362	1.333	1.307	1.281	1.255	1.231	1.208	1,380
1,390	1.572	1.535	1.499	1.466	1.433	1.401	1.371	1.343	1.316	1.290	1.264	1.239	1.216	1,390
1,400	1.583	1.546	1.510	1.476	1.443	1.411	1.381	1.352	1.325	1.299	1.273	1.248	1.225	1,400
1,410	1.594	1.557	1.520	1.486	1.453	1.421	1.391	1.361	1.334	1.308	1.282	1.257	1.233	1,410
1,420	1.605	1.567	1.531	1.496	1.463	1.431	1.400	1.371	1.343	1.317	1.291	1.265	1.242	1,420
1,430	1.616	1.578	1.541	1.507	1.473	1.440	1.410	1.380	1.352	1.326	1.300	1.274	1.250	1,430
1,440	1.627	1.589	1.552	1.517	1.483	1.450	1.419	1.390	1.362	1.335	1.309	1.283	1.259	1,440
1,450	1.638	1.600	1.562	1.527	1.493	1.460	1.429	1.399	1.371	1.344	1.318	1.292	1.267	1,450
1,460	1.649	1.610	1.572	1.537	1.503	1.470	1.439	1.408	1.380	1.353	1.326	1.300	1.276	1,460
1,470	1.660	1.621	1.583	1.547	1.513	1.480	1.448	1.418	1.389	1.362	1.335	1.309	1.284	1,470
1,480	1.671	1.632	1.593	1.558	1.523	1.489	1.458	1.427	1.399	1.371	1.344	1.318	1.293	1,480
1,490	1.682	1.612	1.604	1.568	1.533	1.499	1.467	1.437	1.408	1.380	1.353	1.326	1.301	1,490
1,500	1.696	1.653	1.614	1.578	1.543	1.509	1.477	1.446	1.417	1.389	1.362	1.335	1.310	1,500

SUBSTITUTES FOR MERCURIAL BAROMETERS.

Aneroids and metallic barometers are useful substitutes for the mercurial barometer.

The aneroid is an instrument which has come into extensive use, owing to its convenient size and portability. These recommendations have at once secured its very general adoption.

In the aneroid, atmospherical pressure is measured by its effect in altering the shape of a small, hermetically sealed, metallic box, from which almost all the air has been withdrawn, and which is kept from collapsing by a spring. The top of the box is corrugated.

When the atmospherical pressure rises above the amount which was recorded when the instrument was made, the top is forced inwards, and *vice versa*, when pressure falls below that amount, the top is pulled outwards by the spring. These motions are transferred by a system of levers and springs to a hand which moves on a dial like that of a wheel barometer.

The instrument must be graduated experimentally, as it cannot measure pressure absolutely, but affords indications relatively to a mercurial barometer (its sensibility depending *inter alia* on the quality of the metal of which the box is made).

The principle of the metallic (Bourdon's) barometer is somewhat similar to that of the aneroid.

Aneroids are very sensitive, but unfortunately they do not preserve their accuracy. If a table of corrections be determined for an aneroid, it will be found that after a time it has undergone some change, and that the values of the corrections will require alteration, so that recomparison with a standard barometer will be necessary. In every case of such comparison the readings of the mercurial barometer should be reduced to 32°.

A most serious objection to the scientific utility of these instruments is their liability to injury, owing to rust or to the alteration of force in the springs used in their construction. However, for the reasons above stated, the aneroid is especially suitable for fishermen, pilots, or sea-faring persons employed in boats or small coasting vessels, in which there is not space to suspend a barometer; and, of course, all that is stated regarding the barometer as a weather indicator, applies to the aneroid so far as a single observer is concerned. *For concerted observations accurate mercurial barometers are indispensable.*

5.—THE AMOUNT AND FREQUENCY OF RAIN, ETC.

Rainfall.—The utility of knowing the rainfall of any locality is sufficiently obvious, and little need be said upon the subject. The rain-gauge should be in the hands of every gardener and farmer. In the management of out-door plants and crops, as well as in the construction of cisterns and tanks for the supply of water, a rain-gauge is a valuable assistant. By its use the gardener will be guided in judging how far the supply of moisture to the earth is needed; and he will also see how beneficial is even a hasty shower to growing plants, when he considers that a fall of rain measuring the tenth of an inch in depth corresponds to the deposit of about forty hogsheads per acre. The study of the rainfall of a country is of considerable interest to agriculturists. The health and increase of domestic animals, the development of the productions of the land, as well as the daily labors of the farmer, are dependent upon the excess or deficiency of rain. The statistics of rainfall are not only valuable and interesting from a meteorological point of

view and for agricultural purposes, but are also highly important in connection with sanitary arrangements for towns and engineering operations. This is especially evident to the hydraulic engineer. As rain is an important source of water supply to rivers, canals, and reservoirs, it is evident that a knowledge of the probable fall for any season or month at a given place, as furnished by averages of the observations of former years, will be the data upon which the engineer will base his plans for providing for floods or droughts, while the measurement of the actual quantity which has just fallen, as gathered from the indications of a series of gauges, will suggest to him the precautions to adopt either to economize or conduct away the in-pouring waters.

RAIN-GAUGE.

The rain-gauge adopted for Signal Service stations consists of a funnel-shaped receiver, surmounted by a cylinder 1½ inches in length and 8 inches in diameter. The funnel is placed in a cylindrical reservoir 2.53 inches in diameter and 20 inches in height. The area of the cross-section of the reservoir is to that of the receiver as one to ten, or 1 inch of rain falling in the receiver corresponds with 10 inches of water in the gauge. The amount of rainfall collected in the gauge is measured by means of a graduated rod on which are marked inches and tenths of inches: 1 inch (10 spaces) on the rod corresponds to 0.1 (0.10) of an inch of rain, and 0.1 of an inch (1 space) on the rod to 0.01 of an inch of rain. To provide for very heavy rainfalls the gauge is placed within an outer galvanized iron cylinder 6 inches in diameter and 23½ inches in height, and an opening is made in the top of the small cylinder of the gauge at the height of 20 inches. The gauge will then receive 2 inches (200 spaces, or 20 *lineal* inches on the rod) of rainfall, and when more than this falls the excess will flow over into the attached cylinder. To ascertain the amount of rain when it is in excess of 2 inches, first note the 2 inches in the small cylinder, then empty it, and pour into it the water in the outer cylinder; measure the amount, as already directed, add it to the 2 inches poured from the small cylinder, and the sum will be the total amount of rainfall.

SIGNAL SERVICE RAIN-GAUGE.

Fig. 22.

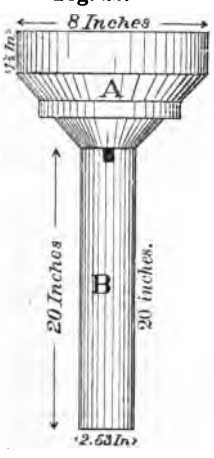
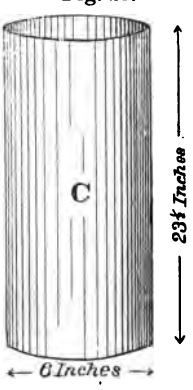


Fig. 23.



DESCRIPTION.

A. Funnel-shaped receiver, area 50.30 inches.
B. Receiving reservoir, area 5.03 inches.
C. Overflow attachment.

SNOW-GAUGE.

Observation.—The *snow-gauge* should be supported vertically, in an open place, between three short wooden posts, its opening being about two feet from the ground. It should be used in the following manner:

When only a very small quantity of snow falls, or of snow alternating with rain, or of dry and fine snow driven by the wind, it should be collected in the snow-gauge, as rain would be in the rain-gauge. But when the snow falls in a sufficient quantity to cover the ground more than an inch deep, the vessel must be emptied, and plunged, mouth downwards, into the snow, until the rim reaches the bottom. A plate of tinned iron, or a small board, may then be passed between the ground and the mouth of the gauge, and the whole reversed. In this way a cylinder of snow, of which the base is superficially one hundred inches, will be cut out and received into the vessel. The operation may be facilitated by placing on the ground a platform of strong board or plank, two or three feet square, for the reception of the snow.

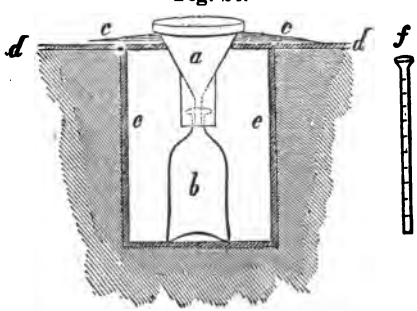
The place selected for this purpose must be one where the snow has not been heaped up, or swept away by the wind, and where it presents, as near as possible, the mean depth of the layer that has fallen. In order to take only the snow which may fall in the interval between two observations, the board should be swept after each measurement, and the place designated by stakes.

Reading.—In the reading of the graduated vessels, the general surface of the liquid must be considered as the true height, and not the edges, which are always raised along the walls of the vessel by capillary attraction.

The collected snow must be melted by placing the gauge, covered with a board to prevent evaporation, in a warm room; and the quantity of water produced measured by pouring it into the glass cylinder. It need hardly be said, that if rain and snow fall the same day, no account will be taken except of what the snow-gauge receives, unless the ombrometer has been observed separately after the rain, and the snow-gauge after the snow. Care must be taken, in these cases, not to count twice the same quantity of fallen water.

During abundant rainfalls, it is well to measure the water more than once a day, or at least immediately after the rain; and the quantity of the rain fallen, together with the time it has lasted, is to be noted separately in the column of remarks.

Fig. 24.



When it freezes, it will be necessary to protect the receiver by filling the interior of the barrel with straw.

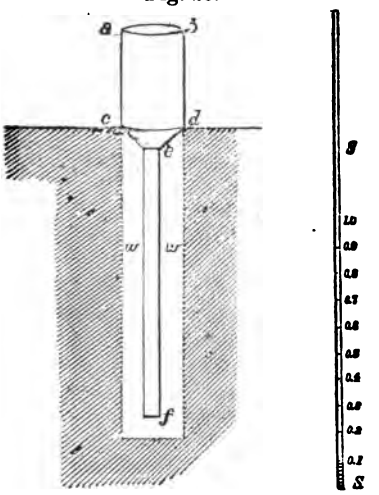
A series of observations has been made at the Smithsonian Institution with rain-gauges of different sizes and different forms, the result of which, as far as the observations have been carried, is to induce a preference for the smallest gauges.

The one which was first distributed by the Institution and the Patent Office to the observers, is represented in Fig. 24. It consists of the funnel *a*, terminated above by a cylindrical brass ring, beveled into a sharp edge at the top, turned perfectly round in a lathe, and of precisely five inches diameter. The rain which falls within this ring is conducted into a two-quart bottle, *b*, placed below to receive it. To prevent any water which may run down on the

outside of the funnel from entering the bottle, a short tube is soldered on the lower part of the former and incloses the neck of the latter. The funnel and bottle are placed in a box or small cask, *e e*, sunk to the level of the ground, which is covered with a board, *d d*, having a circular hole in its center to receive and support the funnel. To prevent the rain-drops which may fall on this board from spattering into the mouth of the funnel, some pieces of old cloth or carpet *c c* may be tacked upon it. The object of placing the receiving ring so near the surface of the earth is to avoid eddies caused by the wind, which might disturb the uniformity of the fall of rain.

In the morning, or after a shower of rain, the bottle is taken up and its contents measured in the graduated tube *f*, and the quantity in inches and parts recorded in the register. The gauge or tube which was first provided for this purpose will contain, when full, only one-tenth of an inch of rain, the divisions indicating hundredths and thousandths of an inch. As this, however, is found to be too small for convenience, another gauge, which will contain an inch of rain, and indicating tenths and hundredths, will be found convenient.

Fig. 25.



It consists of—

1. A large brass cylinder, *a*, *b*, *c*, *d*, 2 inches in diameter, to catch the rain.
2. A smaller brass cylinder, *e f*, for receiving the water and reducing the diameter of the column, to allow of greater accuracy in measuring the height.
3. A whalebone scale, *s s*, divided, by experiment, so as to indicate tenths and hundredths of an inch of rain.
4. A wooden cylinder, *w w*, to be inserted permanently in the ground for the protection and ready adjustment of the instrument.

To facilitate the transportation the larger cylinder is attached to the smaller by a screw-joint at *e*.

Directions for use.—To put up this rain-gauge for use: 1. Let the wooden cylinder be sunk into the ground in a level, unsheltered place until its upper end is even with the surface of the earth. 2. Screw the larger brass cylinder on the top of the brass tube, and place the latter into the hole in the axis of the wooden cylinder, as shown in the figure, and the arrangement is completed.

The depth of rain is measured by inserting the scale into the gauge and noting the height to which it has been wet by the water when it is withdrawn. In order, however, that the water may wet the scale, the superficial grease should be removed by rubbing it with a moist cloth previous to use. In case the water cannot be made to adhere to the scale, a slip of pine or other wood may be made of the same size of the scale, and this inserted in its stead. The quantity of water may then be measured by applying the slip of wood to the scale.

Should the fall of rain be more than sufficient to fill the smaller tube, then the excess must be poured out into another vessel, and the whole measured in the small tube in portions.

Care should be taken to place the rain-gauge in a level field or open space, sufficiently removed from all objects which would prevent the free access of rain, even when it is falling at the most oblique angle

during a strong wind. A considerable space also around the mouth of the funnel should be kept free from plants, as weeds or long grass, and the ground so level as to prevent the formation of eddies or variations in the velocity of the wind.

To ascertain the amount of water produced from snow, a column of the depth of the fall of snow, and of the same diameter as the mouth of the funnel, should be melted and measured as so much rain.

The simplest method of obtaining a column of snow for this purpose is to procure a tin tube, about 2 feet long, having one end closed, and precisely of the diameter of the mouth of the gauge.

With the open end downward, press this tube perpendicularly into the snow until it reaches the ground or the top of the ice, or last preceding snow; then take a plate of tin, sufficiently large to cover it, pass it between the mouth of the tube and the ground, and invert the tube. The snow contained in the tube, when melted, may be measured as so much rain. When the snow is adhesive, the use of the tin plate will not be necessary.

From measurements of this kind, repeated in several places when the depth of the snow is unequal, an average quantity may be obtained.

As a general average, it will be found that about ten inches of snow will make one of water.

Mr. Guest, of Ogdensburg, N. Y., recommends, from an experience of six years, the following as the best plan for ascertaining the amount of melted snow: Procure a cylindrical tin tube of the exact diameter of the mouth of the rain-gauge, and 2 or 3 feet long, so that the snow cannot be blown out. Place this vertically in a properly exposed position, and firmly secure it against the action of the wind, which would otherwise blow it over in a violent storm. After the snow has ceased to fall, bring the vessel with its contents into the house, near a fire, which will gradually melt the snow, and afterwards measure the water produced by means of the rain-guage.

There is some difference of opinion as to the proper area of the collecting funnel, but it has been shown by most carefully conducted experiments that the difference in indications between gauges of various apertures, ranging from 2 inches to 24 inches in diameter, is very small, hardly exceeding one per cent.

APPARATUS EMPLOYED FOR REGISTERING THE DIRECTION, PRESSURE, AND VELOCITY OF THE WIND.

The vane.—The instrument by which the wind's direction is most generally noted is the vane, or weather-cock, and all that need be said of it here is that the points north, east, south, and west, usually attached to it, should indicate the *true* and not the *magnetic* directions, and that care should be taken to prevent its setting fast. Very complicated instruments are required for ascertaining the pressure and velocity of the wind, and these are called *anemometers.*

Placing.—The *wind-vane* should be set in a place as free and open as possible, away from every obstacle, and especially from high buildings. It should exceed in elevation by at least eight or ten feet the neighboring objects.

As a flat vane is always in a neutral line, an accurate and sensitive one is made by fastening two plates together at an angle of about ten degrees, forming a long wedge. Thus,

Fig. 26.

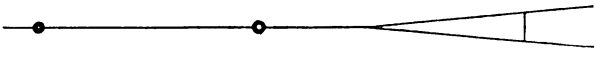
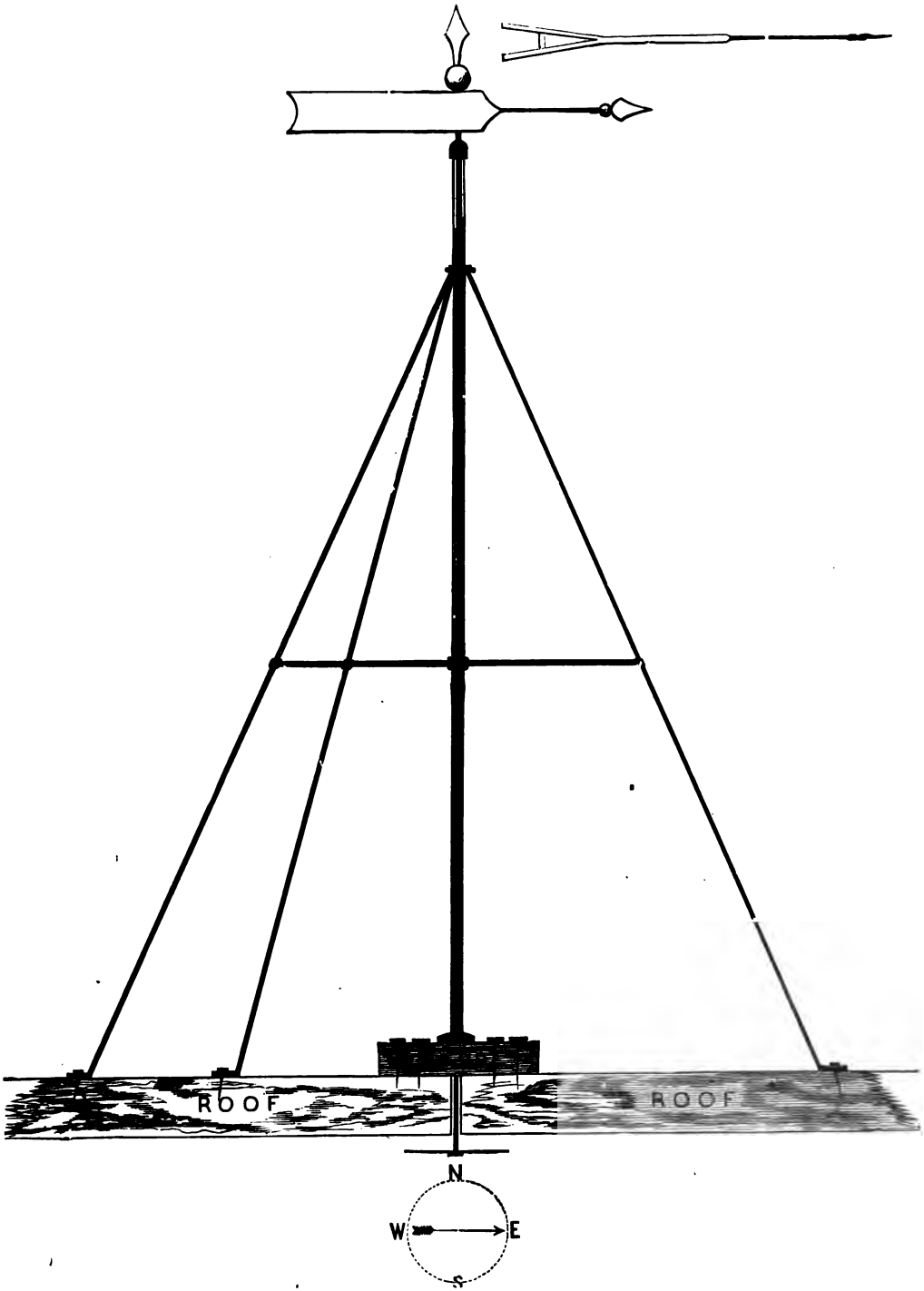


TABLE VII.—Continued.

Temperature.	Inches.															Temperature.
	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0	30.5	31.0	
°	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	°
51	.048	.049	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060	.061	.062	51
52	.050	.052	.053	.054	.055	.056	.057	.058	.059	.060	.061	.062	.063	.064	.065	52
53	.053	.054	.055	.056	.057	.058	.059	.060	.061	.063	.064	.065	.066	.067	.068	53
54	.055	.056	.057	.058	.059	.060	.062	.063	.064	.065	.066	.067	.068	.070	.071	54
55	.057	.058	.059	.060	.062	.063	.064	.065	.066	.068	.069	.070	.071	.072	.073	55
56	.059	.060	.061	.063	.064	.065	.066	.068	.069	.070	.071	.073	.074	.075	.076	56
57	.061	.062	.064	.065	.066	.068	.069	.070	.071	.073	.074	.075	.076	.078	.079	57
58	.063	.065	.066	.067	.069	.070	.071	.073	.074	.075	.077	.078	.079	.081	.082	58
59	.065	.067	.068	.070	.071	.072	.074	.075	.076	.078	.079	.080	.082	.083	.085	59
60	.068	.069	.070	.072	.073	.075	.076	.077	.079	.080	.082	.083	.085	.086	.087	60
61	.070	.071	.073	.074	.075	.077	.078	.080	.081	.083	.084	.086	.087	.089	.090	61
62	.072	.073	.075	.076	.078	.079	.081	.082	.084	.085	.087	.088	.090	.091	.093	62
63	.074	.076	.077	.079	.080	.082	.083	.085	.086	.088	.089	.091	.093	.094	.096	63
64	.076	.078	.079	.081	.082	.084	.086	.087	.089	.090	.092	.094	.095	.097	.098	64
65	.078	.080	.082	.083	.085	.086	.088	.090	.091	.093	.095	.096	.098	.100	.101	65
66	.080	.082	.084	.085	.087	.089	.090	.092	.094	.096	.097	.099	.101	.102	.104	66
67	.083	.084	.086	.088	.089	.091	.093	.095	.096	.098	.100	.102	.103	.105	.107	67
68	.085	.086	.088	.090	.092	.094	.095	.097	.099	.101	.102	.104	.106	.108	.109	68
69	.087	.089	.090	.092	.094	.096	.098	.100	.101	.103	.105	.107	.109	.110	.112	69
70	.089	.091	.093	.095	.096	.098	.100	.102	.104	.106	.108	.109	.111	.113	.115	70
71	.091	.093	.095	.097	.099	.101	.102	.104	.106	.108	.110	.112	.114	.116	.118	71
72	.093	.095	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115	.117	.119	.120	72
73	.095	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115	.117	.119	.121	.123	73
74	.097	.099	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120	.122	.124	.126	74
75	.100	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120	.122	.125	.127	.129	75
76	.102	.104	.106	.108	.110	.112	.114	.117	.119	.121	.123	.125	.127	.129	.131	76
77	.104	.106	.108	.110	.112	.115	.117	.119	.121	.123	.126	.128	.130	.132	.134	77
78	.106	.108	.110	.113	.115	.117	.119	.122	.124	.126	.128	.130	.133	.135	.137	78
79	.108	.110	.113	.115	.117	.119	.122	.124	.126	.128	.131	.133	.135	.137	.140	79
80	.110	.113	.115	.117	.119	.122	.124	.126	.129	.131	.133	.136	.138	.140	.143	80
81	.112	.115	.117	.119	.122	.124	.126	.129	.131	.134	.136	.138	.141	.143	.145	81
82	.114	.117	.119	.122	.124	.126	.129	.131	.134	.136	.138	.141	.143	.146	.148	82
83	.117	.119	.121	.124	.126	.129	.131	.134	.136	.139	.141	.143	.146	.148	.151	83
84	.119	.121	.124	.126	.129	.131	.134	.136	.139	.141	.144	.146	.149	.151	.154	84
85	.121	.123	.126	.128	.131	.133	.136	.139	.141	.144	.146	.149	.151	.154	.156	85
86	.123	.126	.128	.131	.133	.136	.138	.141	.144	.146	.149	.151	.154	.156	.159	86
87	.125	.128	.130	.133	.136	.138	.141	.143	.146	.149	.151	.154	.157	.159	.162	87
88	.127	.130	.133	.135	.138	.141	.143	.146	.149	.151	.154	.157	.159	.162	.165	88
89	.129	.132	.135	.137	.140	.143	.146	.148	.151	.154	.156	.159	.162	.165	.167	89
90	.131	.134	.137	.140	.142	.145	.148	.151	.153	.156	.159	.162	.164	.167	.170	90
91	.134	.136	.139	.142	.145	.148	.150	.153	.156	.159	.162	.165	.167	.170	.173	91
92	.136	.139	.141	.144	.147	.150	.153	.156	.158	.161	.164	.167	.170	.172	.175	92
93	.138	.141	.144	.147	.149	.152	.155	.158	.161	.164	.167	.170	.172	.175	.178	93
94	.140	.143	.146	.149	.152	.155	.157	.161	.163	.166	.169	.172	.175	.177	.180	94
95	.142	.145	.148	.151	.154	.157	.160	.163	.166	.169	.172	.175	.178	.180	.185	95
96	.144	.147	.150	.153	.156	.159	.162	.165	.168	.171	.174	.178	.181	.183	.183	96
97	.146	.149	.152	.156	.159	.162	.165	.168	.171	.174	.177	.180	.183	.186	.189	97
98	.148	.152	.155	.158	.161	.164	.167	.170	.173	.176	.179	.183	.186	.188	.191	98
99	.151	.154	.157	.160	.163	.166	.169	.173	.176	.179	.182	.185	.188	.191	.194	99
100	.153	.156	.159	.162	.165	.169	.172	.175	.178	.181	.184	.188	.191	.194	.197	100

FIG. 27.



Face p. 77.

The longer the vane the shorter the pulsations, and the steadier the action will be. A small-sized vane may be ten or twelve inches wide and four feet long.

Observation.—The observation of this instrument demands some care. In winds of considerable strength the vane is never at rest or fixed in the same direction; it oscillates incessantly, and its oscillations increase in amplitude with certain winds, and with the violence of the wind. We must then note the mean direction between the extremes. When the wind is very feeble perhaps it may not have sufficient force to set the vane in motion; in this case, as when the air is calm, great mistakes might be made by registering the direction marked by the index, for its position indicates not the direction of the existing wind but that of the last wind that had the power to set the instrument in motion. When the index is immovable and there is no oscillation we must give up its indications and refer to the movement of light bodies, as that of the leaves of trees and the smoke of chimneys, to determine the direction of these feeble currents of air. During the night the direction of the wind may be easily ascertained by raising the hand in the air with one finger wet. The least motion in the air increases evaporation, and a sensation of cold is experienced on the side of the finger turned towards the wind.

The *direction* of the wind must be noted, following the eight principal points of the compass—north, northeast, east, southeast, south, southwest, west, and northwest. For the additional observations during storms the degrees may be indicated in order to follow more exactly the rotation of the wind, or at least sixteen points of the compass, viz, N., N.N.E., N.E., E.N.E., E., E.S.E., S.E., S.S.E., S., S.S.W., S.W., W.S.W., W., W.N.W., N.W., N.N.W.

The lower or surface wind often has a different direction from that which prevails in the upper regions of the atmosphere, and this is generally the case when the wind turns and the weather is going to change, also during storms and great atmospheric movements.

The manner in which the wind turns, or rather the order in which the winds succeed one another in the course of the day, must be watched very carefully. It will be seen that they commonly follow in regular order; they pass from the east by the south to the west, and from the west by the north to the east. Nevertheless, they sometimes go back in the opposite direction, particularly during storms. A little memorandum, summing up in a few words at the end of each day this course of the wind, together with the hours of the wind's changes, is very valuable. It may be entered in the column of remarks.

When there are no instruments for determining the velocity of the wind, its force must be estimated according to the following scale:

SIGNAL-SERVICE SCALE.

0	Calm.
1 to 2 miles per hour	Light wind.
3 to 5 " " "	Gentle.
6 to 14 " " "	Fresh.
15 to 24 " " "	Brisk.
25 to 39 " " "	High.
40 to 59 " " "	Gale.
60 to 79 " " "	Storm.
80 miles per hour and above	Hurricane.

The general appearance of the vane in use in the Signal Service and the location of the several parts are shown in Fig. 27. The iron straps

which unite the two parts of the foot-block must be taken off and the block separated before raising the vane, in order to put the iron socket holding it in proper position. After the vane is up the pieces must be fastened firmly together again by these straps.

The instrument generally used for determining the velocity of the wind is Robinson's anemometer, which consists of four hollow hemispherical cups mounted upon conjugate diameters, or arms, with their diametrical planes placed vertically and facing the same way upon a vertical axis, which has at its lower extremity an endless screw. The axis is supported so as to turn with as little friction as possible. The endless screw is placed in gear with a wheel which moves the two dials, which register the number of revolutions of the cups.

It has been proven, both by theory and experiment, that the center of any one of the cups so mounted and set in motion by the wind revolves with one-third of the wind's velocity. If, therefore, the diametrical distance between the centers of the cups be one foot, the circle described by the centers in one revolution is 3.1416 feet, and the velocity of the wind will be three times this, or 9.42 feet, which must be referred to time for the absolute rate. The instrument is sometimes made with the centers of the cups 1.12 feet apart, so that the circle described is $\frac{1}{1500}$ of a mile in circumference. Hence, to produce one revolution of the cups, the wind must travel three times as fast, or $\frac{1}{500}$ of a mile. Therefore, 500 revolutions will be produced by one mile of wind.

The pattern of anemometer used in the Signal Service has the registering dials mounted concentrically. The outer dial has one hundred and the inner dial ninety-nine divisions. As the dials are moved by the same wheel, they will move forward one hundred divisions in the same time (Fig. 28). The outer dial having one hundred divisions, the inner dial will complete one revolution and its zero be one division beyond or to the left of the zero of the outer dial when the outer dial has completed one revolution, the zeros of the scales coinciding at the time the instrument was set in motion. Thus the revolutions made by the outer dial are recorded on the inner one, the number of revolutions being shown by the number of divisions of the scale on the inner dial between the zero of that scale and the zero of the outer one. In taking the reading of the anemometer at any time the hundreds and tens of miles are read from the inner scale, and the miles and tenths of miles are read from the outer one. Take from the inner scale the hundreds and tens of miles contained between the zero of that scale and the zero of the outer one, and the miles and tenths of miles on the outer scale contained between the zero of that scale and the index of the instrument, and the sum of these readings will be the reading of the instrument at the time of making the observation.

When the anemometer is not furnished with an index-point the center of the small wheel which gives motion to the dials will be taken as the reference point.

The total movement for the twenty-four hours will be obtained in the following manner: Subtract the reading of the anemometer at 12 noon of the preceding day from the reading taken at 12 noon of the current day, and the difference will be the total movement of the wind. When the reading of the anemometer is less than the reading of the preceding day, nine hundred and ninety miles will be added to it, and the remainder, after subtracting the reading of the preceding day, will be the total movement.

Example: The dial reading of to-day is 91, and that of yesterday was

950, hence we have $91 + 990 = 1081$; $1081 - 950 = 131$, the total movement of the wind in miles during the past twenty-four hours.

Anemometers must be kept carefully and thoroughly oiled to prevent friction and injury to the several bearings. Especial attention must be given to the large dial-screw, and when found loosened it must at once

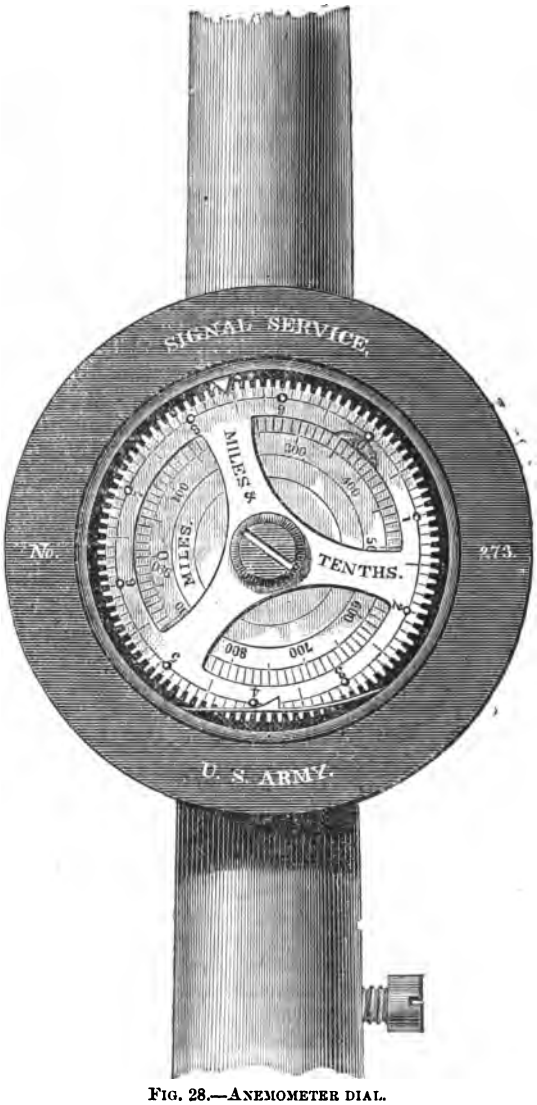


FIG. 28.—ANEMOMETER DIAL.

be tightened, but care must be taken not to screw it up tight enough to interfere with the free motion of the dials. Other instruments are in use which determine the force of the wind by measuring the pressure exerted upon a given surface.

The Vienna Congress has recommended the introduction of Professor Wild's pressure gauge, which is in use in Russia and Switzerland. This

consists of a rectangular plate hung on hinges on a horizontal axis. The angle which this makes with the vertical indicates the force of the wind.

The pressure of the wind has been experimentally proved to vary as the square of the velocity, the relation being V^2 (velocity) $= 200 \times P$ (pressure). From this formula, therefore, the pressure can be calculated corresponding to the observed velocity.

ATMOSPHERIC ELECTRICITY.

Although observations on atmospheric electricity are not called for from ordinary observers, it may not be amiss to give some notes on the subject in order to direct more attention to it than it has hitherto obtained.

The occurrence of lightning and thunder storms should be noted in the "Remarks" column, but in addition to these indications of great electrical disturbance taking place in the atmosphere, it is desirable that observations should be made upon the electricity existing in the air under ordinary circumstances, so as to determine, firstly, whether it is positive or negative, and, secondly, what is its intensity.

Electroscopes.—The simplest instruments of this nature, viz, the Gold Leaf, Bennett's, and Bohnenberger's, are sufficient to show the nature of the electricity present in the air, but it is always found that very little electricity can be observed near the ground, and in order to obtain satisfactory indications the conductor of the electroscope should be brought into contact with the air at some distance from the earth's surface, by means of a collector.

Collectors.—A simple rough method of doing this is to shoot a metallic arrow upwards into the air, the arrow being tied to one end of a conducting string, the lower end of which carries a ring which rests upon the electroscope. The arrow being shot upwards, the electroscope will be found to be electrified, as it mounts; and when the ring leaves the plate the instrument will indicate the state of electrification of the air at that point where the arrow is at the time.

This manner of observing is simplified by substituting a long conductor reaching upwards; a gilded fishing-rod may be employed, its lower extremity being insulated.

The usual method employed, however, is Volta's, in which the electricity is collected by means of a flame, burning at a height, either in a lantern hung to a mast, and connected to the electroscope by a wire, or by a slow-burning match attached to the top of a long metal rod.

The electricity of the air in the neighborhood of the flame, by its inductive action upon the conductor, causes electricity of the opposite nature to accumulate at the upper extremity, where it is constantly carried off by the convection currents in the flame, leaving the conductor charged with electricity of the same kind and potential as the air.

The principle of Volta's method has been made use of by Sir W. Thomson in his water-dropping collector, now employed in observatories, and found to be extremely suitable for the observation of atmospheric electricity, in connection with his electrometer.

A copper can is placed on an insulating support, which may be of ebonite, having the surface thinly coated with pariffine; or of glass, surrounded with pumice-stone impregnated with sulphuric acid. From the can a small pipe projects a considerable distance into the air, and terminates in fine jet. The can being filled with water, and the tap which opens into the jet turned on, a small stream of water is allowed to flow

out, care being taken that it is so small that it shall break into drops immediately after leaving the nozzle of the tube.

In half a minute from the starting of the stream, the can will be found to be electrified to the same extent as the air at the point of the tube.

This collector cannot be employed during the time of frost, owing to the freezing of the water in the jet pipe. At such times, therefore, and when observations are to be made with a portable instrument, a slow-burning match should be used. Sir W. Thomson recommends for this purpose blotting paper, steeped in a solution of nitrate of lead, dried, and rolled into matches.

Position of collector.—Since electrical density is greater on projecting surfaces, and less on hollow surfaces than on planes, the collector should not be near trees or houses, nor within a closed space.

Peltier's electrometer.—Another form of instrument which is very highly recommended is Peltiers's electrometer, which has been used for more than thirty years at Brussels by the late M. Quetelet, and for upwards of twenty years at Utrecht. The instrument is described in the *Annuaire Météorologique de France*, 1850, p. 181, and in the report of the British Association, 1849, Transactions of Sections, p. 11.

INSTRUCTIONS FOR OBSERVING AURORAS.

Though the aurora borealis has received attention during a considerable portion of the last two centuries, definite information is still wanting on several points which may serve as the basis of a sound induction as to its cause. These relate particularly to the actual frequency of its appearance; its comparative frequency in the different months of the year and different hours of the day; the connection of its appearance with other atmospherical phenomena; the elevation and extent of visibitity of the arch; and whether the same or different phases are presented to individuals at different stations at the same moment of time; finally, the precise influence of the arches, streams, &c., on the magnetic condition of the earth; and whether any unusual electrical effects can be observed during the appearance of the meteor.

Auroral phenomena may be divided into the following classes:

1. A faint light in the north, without definite form or boundary.
2. A diffused light, defined by an arch below.
3. Floating patches of luminous haze—sometimes striated.
4. One or more arches, resembling the rainbow, of uniform white color, retaining the same apparent position for a considerable time, and varying in luminosity.
5. A dark segment, appearing under the arch.
6. Beams, rays, streamers, waves, transverse and serpentine bands, interrupted or checkered arches, frequently tinged with color, and showing rapid changes in form, place, and color.
7. Auroral corona, or a union of beams south of the zenith.
8. Dark clouds accompanying the diffuse light.
9. Sudden appearance of haze over the whole face of the sky.

The following may serve as a scale of brightness:

1. Faint. 2. Moderate. 3. Bright. 4. Very bright.

GENERAL DIRECTIONS.

1. Make a regular practice of looking for auroras every clear evening, from 8 to 10 o'clock, or later. Record the result, whether there be an aurora or not.
2. Note the time of observation, and compare the watch used with a good clock, as soon after as is convenient.
3. Make a return of the latitude and longitude of the station.
4. Note the class to which the auroral phenomenon belongs.
5. If it be an arch, note the time when the convex side reaches any remarkable stars, when it passes the zenith, disappears, &c.
6. If the arch be stationary for a time, note its position among the stars, so that its altitude may be determined.
7. If it be a streamer or beam, note its position, and the time of its beginning and ending.
8. If motion be observed in the beams, note the direction, whether vertically or horizontally, to the east or west.

9. Note the time of the formation of a corona, and its position among the stars.

10. Note the time of the appearance of any black clouds in the north near the aurora; also, if the sky be suddenly overcast with a mist at any time during the auroral display.

11. Give the direction and force of the wind at the time.

12. Note if any electrical effects are observed.

13. Note the effect upon a delicately suspended magnetic needle.

14. The date, hour, and minute of the beginning and ending of auroras should be carefully noted, as well as the azimuth and altitude of each extremity and of the crown of any arch of light, and the same data for any corona or glory that may be formed.

When the observer is familiar with the names of the principal fixed stars, he may locate the arch or crown by reference to them, but it is preferable that he should observe directly the altitude and azimuth.

Altitudes are expressed by degrees from the horizon to the zenith. If any circle be divided into three hundred and sixty parts, and the radial lines connect these parts with the center, each pair of lines subtend an angle of one degree; the fourth part of the circle will subtend an angle of ninety degrees or one right angle, and the corresponding radii are perpendicular to each other; thus the zenith (that point of the heavens immediately above the observer) is ninety degrees from the horizon, or, in other words, its altitude is 90°. A point half way up from the horizon to the zenith has an altitude of 45°.

Azimuths are also expressed in degrees, but are measured on the horizontal plane, and will be recorded as is done in astronomy, from the south point to the westward, passing, successively, the west, north, and east points of the compass until 360° have been passed over, and the south point is again reached.

Observers should be particular as to the date of the aurora; and when it begins in the evening of one day and continues into the early morning of the next day, it will be entered as occurring on the *first* day, but its details will be given in the record as occurring between the hours of its actual beginning and ending. Thus, an aurora that began on the evening of the 12th of January and continued until the early morning of the 13th would be entered as the aurora of the 12th, but its details would be recorded as occurring, for instance, between the hours of 10 p. m. of January 12 and 2 a. m. of January 13.

Professor Olmstead, in a paper published by the Smithsonian Institution, classifies different auroras as follows:

"CLASS I. This is characterized by the presence of at least *three* out of four of the most magnificent varieties of form, namely, arches, streamers, corona, and waves. The distinct formation of the corona is the most important characteristic of this class; yet, were the corona distinctly formed, without auroral arches or waves, or crimson vapor, it could not be considered as an aurora of the first class.

"CLASS II. The combination of *two* or more of the leading characteristics of the first class, but wanting in others, would serve to mark class the second. Thus the exhibition of arches and streamers, both of superior brilliancy, with a corona, while the waves and crimson columns were wanting, or of streamers with a corona, or of arches without a corona, without streamers or columns (if such a case ever occurs), we should designate as an aurora of the second class.

"CLASS III. The presence of only *one* of the more rare characteristics, either streamers or an arch, or irregular coruscations, but without the

formation of a corona, and with but a moderate degree of intensity, would denote an aurora of the third class.

"CLASS IV. In this class we place the most ordinary forms of the aurora, as a mere northern twilight, or a few streamers, with none of the characteristics that mark the grander exhibitions of the phenomenon."

The same author remarks:

"On the evening of the 27th of August, 1827, after a long absence of any striking exhibition of the aurora borealis, there commenced a series of these meteors, which increased in frequency and magnificence for the ten following years, arrived at a maximum during the years 1835, 1836, and 1837, and, after that period, regularly declined in number and intensity until November, 1848, when the series appeared to come to a close. The recurrence, however, of three very remarkable exhibitions in September, 1851, and of another of the first class as late as February 19, 1852, indicates that the close was not so abrupt as was at first supposed; but still there was a very marked decline in the number of great auroras after 1848, and there has been scarcely one of the higher class since 1853.

OBSERVATIONS OF CLOUDS, WEATHER, ETC.

SKY.

The blue color of the sky has an intimate connection with the hygrometrical state and the electrical tension of the air; it may be noted by the expressions *dark*, *light*, and *grayish*.

Haze and dry mist.—The transparency of the air is often disturbed by a kind of vapor, which gives a whitish tint to the sky and dims the rays of the sun. This phenomenon, known in Europe under different names, appears frequently after long droughts; in this country it seems to characterize the Indian summer. In Europe, and elsewhere, an intensely dry mist, which is, probably, a different phenomenon, sometimes follows great earthquakes or volcanic eruptions. The observer will carefully enter phenomena of this kind, and the circumstances under which they appear or disappear. If he has an opportunity, as in a high station, he should endeavor to ascertain if there is an upper limit, and what is the thickness of the layer of haze or dry mist. Observations made in the Alps prove that the atmosphere is often entirely free from it at a height of two thousand feet, when it is very intense in the plain. Does a thunder-storm or rain always cause it to disappear? Do the prairie fires have any relation with kindred phenomena? Does it appear more frequently in certain seasons than in others?

DEW.

The *dews*, especially when they are abundant, and

The *white frosts*, or frozen dew, particularly the first and last of the year, and their intensity, must be entered.

FOG.

Fog.—The moment must be noted when it forms and when it dissipates, as *falling* fog, *rising* fog; its density, as *dense* fog, *slight* fog.

Mists hanging over forests, moors, meadows, rivers, or the like.

Notice must be carefully taken of the time of their appearance or disappearance; these are the most important facts in regard to them.

These fogs must not be confounded with the dry fog, which belongs to another class of phenomena, which have been spoken of above.

CLOUDS.

The *cloudiness* or the quantity of clouds, after some practice, can be easily estimated, in accordance with the following scale. Thus, we understand by—

0. A clear sky, entirely free from clouds;

10. The whole sky covered with clouds, or a dense fog, or rain; and by 1, 2, 3, 4, 5, 6, 7, 8, 9, the different degrees of cloudiness which lie between these:

1. Denotes, for instance, nine times as much blue sky as clouds.

5. An equal amount of clouds and blue sky.

9. Nine times more clouds than blue sky.

The form of the clouds will be indicated by the terminology of Howard. According to this, they are distinguished by their external forms into three kinds; the *cirrus*, *cumulus*, and the *stratus*, to which belong four transition forms, the *cirro-cumulus*, the *cirro-stratus*, the *cumulo-stratus*, and the *nimbus*. The most remarkable of these forms may be characterized in the following manner:

The *cirrus* (Nos. 1, 2, 3, and 4) or cat-tail of the sailors, is composed of loose filaments, the whole of which sometimes resembles a pencil, sometimes curly hair, sometimes a fine net, or a spider's web.

The *cumulus* (Nos. 9 and 10) or summer cloud, the cotton-bale of the sailors, often shows itself under the form of a hemisphere resting on a horizontal base. Sometimes these half spheres are piled upon one another, forming those large accumulated clouds in the horizon which resemble at a distance mountains covered with snow.

The *stratus* is a horizontal band, which is formed at sunset and disappears at sunrise.

The *cirro-cumulus* (Nos. 7, 8 and 11) are those small rounded clouds which are often called fleecy; when the sky is covered with clouds of that kind it is said to be mottled.

The *cirro-stratus* (Nos. 5 and 6) is composed of small bands, formed of closer filaments than those of the cirrus, for the rays of the sun often find it difficult to penetrate them. These clouds form horizontal beds, which, at the zenith, seem composed of a great number of loose clouds, while at the horizon a long and very narrow band is seen.

The *cumulo-stratus* (Nos. 9 and 10) is a mass of heaped-up and dense cumuli. At the horizon they often assume a dark or bluish tint, and pass into the condition of *nimbi*, or rain-clouds.

The *nimbus* (No. 12) is distinguished by its uniform gray tint, its fringe and indistinct edges; the clouds composing it are so blended that it is impossible to distinguish them.

But besides these principal forms there are several intermediate, to which it is difficult to assign a name. They must be referred to the form which they most resemble.

They may be entered in the journal by means of the following abbreviations:

St.	i. e.	Stratus.
Cu.	"	Cumulus.
Cir.	"	Cirrus.
Cir. st.	"	Cirro-stratus.
Cu. st.	"	Cumulo-stratus.
Cir. cu.	"	Cirro-cumulus.
Nim.	"	Nimbus.

If several of these forms are visible, the most frequent should be underlined, and the others should follow the order of their frequency. The distribution of the clouds in the sky should be noted, whether they are dispersed or accumulated in a special region of the heavens, in the horizon, at the zenith, &c.

STATE OF WEATHER.

The state of the weather will be determined as follows:

Clear, when the sky is three-tenths or less than three-tenths covered with clouds; *fair*, when the sky is from four-tenths to seven-tenths (inclusive) covered; *cloudy*, when the sky is more than seven-tenths covered; *sprinkling*, when a few drops of rain are falling; *light rain*, when light rain is falling; *heavy rain*, when heavy rain is falling; *sleeting*, when sleet is falling; *light snow*, when light snow is falling; *heavy snow*, when heavy snow is falling; *threatening*, when the clouds indicate approaching rain or snow; *clearing up*, when the clouds indicate clearing weather after rain or snow; *thunder-storm with light or heavy rain*, when a thunder-storm is prevailing at the moment of the observation, or the rain is still falling, although neither thunder has been heard nor lightning observed for some time previous to the observation. *Foggy, smoky, or hazy*, when either prevails to such an extent as to obscure the sky; in other cases the record in the cloud spaces will show the extent of either prevailing, and the weather will be recorded as "clear," "fair" or "cloudy," according to the amount of cloudiness.

RAIN.

It is necessary to note as accurately as possible the hour at which the rain begins and ends.

Precipitation which is too small to measure will be noted in the proper space by a dash (—), and the word "Inapplicable" written on the margin of the page, the person taking the observation always being careful to connect the dash (—) and the note by an asterisk (*).

Absence of precipitation will be indicated by the figure zero (0).

There will also be noted:

The snow.—The period of the first and last snow, the size of the flakes, their forms.

Sleet, which consists in small balls of snow, white and opaque, commonly without a crust of ice, like the opaque nucleus found within hail-stones, falling more frequently in spring and in autumn.

Frozen rain drops should be distinguished from the preceding forms; they make little balls of transparent ice.

Hail.—Indicate the size, form and average weight of the hail-stones. The number of different strata observed in the larger stones. Whether any of them contain particles of sand or any other foreign matter. The extent and course of the phenomenon.

THUNDER-STORMS.

The time of beginning and ending of the storm must be indicated as exactly as possible; the point of the horizon whence it rises, the direction of the clouds, of the wind and its variations, and, if possible, the quantity of rain before and during the storm; of hail, &c., which falls; note if it passes over the place of the observation, or at a distance; if it is accompanied, or not, with strong electrical detonations and numer-

ous lightnings. It will be well to ascertain the state of the meteorological instruments every five minutes during the storm, especially of the barometer and the thermometer.

TORNADOES AND LAND-SPOUTS.

These whirlwinds, or violent and circumscribed storms, give rise to very complex phenomena, which are difficult to observe. All the meteorological circumstances, however, should be minutely noted; among others the following:

The course of the barometer, which almost always sinks much and rapidly; that of the thermometer, which usually indicates an elevation of temperature; the region of the heavens in which the thunder-storm frequently accompanying them is formed; the form and color of the clouds; the direction and intensity of the wind; the frequency, the size, and the form of the lightnings; finally, the apparent shape of the land-spout, its variations, its course, and its effects upon the trees and upon the ground.

ADDITIONAL OBSERVATIONS DURING STORMS.

Everybody knows the importance of a knowledge of the laws of those great movements of the atmosphere which embrace almost the whole extent of the continent. It is only in following them, step by step; by observing their different phases at different places, and by combining the facts obtained, that the meteorologist can be enabled to discover the laws which preside over these great phenomena. For this, the three regular observations a day are insufficient; it is then earnestly recommended to observers, who desire to contribute effectually to the solution of this great problem, not to content themselves with the prescribed number, but to add as many more as possible during the continuance of remarkable storms; noting not only the state of the instruments from hour to hour, if possible, but following with attention all the meteorological changes. These observations must be entered on the reverse of the sheet, under the head of Casual Phenomena, which is particularly reserved for this purpose.

The principal points to which attention should be directed are the following:

The *barometer*, announces by a considerable fall, the approach of a storm. Then it begins to rise during its continuance, and only resumes its normal equilibrium after its close. Note especially the following points:

Was the storm preceded by a noticeable or sudden rise previous to the fall;

Note the state of the barometer, and the time when the fall becomes more rapid;

Its state, and the time, when it is lowest and when the rise begins;

The highest point which it reaches during or immediately after the storm.

If alternations of rising and falling take place, the fact should be mentioned and the time noted.

The thermometer.—The fluctuations of the thermometer in the same time as those of the barometer should also be noted, and their connection with the changes of the wind be observed.

The wind.—It is of the greatest importance to observe the course of the winds through the entire height of the atmosphere during the whole

continuance of the storm, by means of the wind-vane and of the clouds in the different layers of the atmosphere.

The hour when the wind begins, and the direction whence it comes;

The moment of its greatest violence;

The instant it changes its direction, and when it takes the direction it keeps to the end of the storm.

It should be stated if the wind blows in a continuous manner or in squalls, and what is its force.

If there should be one or more moments of calm, the hour and duration will be indicated.

Great care must be taken at each observation to note also the direction of the different layers of clouds, which will very often be found different from that of the wind below, for the whole duration of the storm.

The clouds.—Are there certain forms of clouds which announce the approach of a storm? It is necessary, in this connection, to watch the formation of the cirrus, the cirro-cumulus, cirro-stratus, their arrangement in parallel lines, their course, and their directions. Note the quarter of the sky first covered with clouds; the moment when it is entirely covered; if there are later clear spots or not; the moment when the sky clears off.

The rain.—Note the hour at which the rain or the snow begins and ends; measure the quantity fallen while the storm lasts.

ACCIDENTAL METEORIC PHENOMENA.

These will be entered in the tables, in the place reserved for this purpose on the opposite side of the sheet. If the space is not sufficient for the description to be given, the phenomenon should be simply noted, and reference made to a separate account for details. Thus:

The solar and lunar halos—that is, the colored circles sometimes observed round the sun and moon. Distinguish the small ones, the ring of which measures only a few degrees, from the large or real halos, the ring of which has a diameter of about forty-four degrees. It must be stated whether they are connected with other circles, as is sometimes the case. Care must be taken not to mistake a part of a grand halo for a rainbow. Note whether these appearances are, or are not, ordinarily followed by rain.

The Parhelia and Paraselenes (mock suns and moons).—Describe exactly their forms and the state of the heavens at the moment of their appearance.

Rainbows, simple or double.

An extraordinary *redness* of the sky, either in the morning or evening; the particular color of the sun and of the moon at their rising, especially in fair days.

Heat lightnings without thunder, and sometimes without clouds; indicate their direction and the aspect of the clouds in their neighborhood.

The *aurora borealis*, or northern light, for the observation of which the special instructions must be followed.

Shooting-stars.—The observer must be particularly attentive to their frequency during the periods near the 10th and 11th of August and the 10th and 15th of November, in which it is supposed that they are more numerous than at any other time. He will designate the quarter of the heavens from which they seem to issue and their direction.

Fireballs.—Describe their aspect, their size, their course in the heavens, and note the exact hour of their appearance.

All the other luminous phenomena which present any extraordinary appearance should be noted down.

These descriptions should be made in simple and well-defined terms. The observer will take great care to enter scrupulously *what he sees* without drawing any conclusion or attempting any explanation of the phenomenon. He ought to reflect that, in order to make a good observation, he must keep his mind in a state of perfect freedom in respect of any preconceived theory, and to consider the phenomenon before him as being one of the data for the foundation of the science, and that the knowledge of the truth will depend upon the fidelity of his observation.

TIME OF OBSERVATIONS.

The time of observations will be the mean time at each station. The observations will be made three times daily, viz:

At 7 o'clock a. m.
2 o'clock p. m.
9 o'clock p. m.

The mean of these three hours will be very nearly the true mean, as it would be obtained by observation made every hour of the day and night.

The rain gauge will be observed only once a day, unless very abundant rains should make a second measurement necessary. The best time will be 2 o'clock p. m., the observation being made daily; if another hour is selected it should, when once fixed, remain the same.

The maxima and minima thermometers will be read once a day, always at the same hour. The most suitable hour will be 9 o'clock in the evening.

If an observer desires to examine the daily oscillations of the barometer, he will also observe at 10 a. m. and 4 p. m., which give the daily maximum and minimum. It will be well to note also, at the same time, the state of the hygrometer.

If he desires to complete the data upon the diurnal course of the temperature, he will add observations of the thermometer at 10 a. m. and 6 p. m. In all cases it is desirable that, if an observer has leisure to increase the number of the hours of observations, he should fix them at equal intervals between the principal hours indicated above.

Besides these observations at regular hours, additional observations ought to be made during remarkable storms, as has been remarked above.

It is very important that the observations should be made at the exact hour, fixed by a well-regulated watch. All the instruments should be read rapidly, so that the observations may be as simultaneous as possible.

The order in which they are to be observed will be as follows:

A few minutes before the hour, observe the thermometer before opening the window; then wet the psychrometer. While it is taking the temperature of evaporation, note the height of the barometer, observe the wind, the course of the clouds, their quantity, the aspect of the sky, &c.; then read the temperature of the psychrometer.

The observations must be recorded for each instrument at the moment when they are made, without trusting anything to the memory. The indications of the instruments should be exactly noted.

If the observer has been unavoidably delayed from making the observations at the exact hour, he will note in the column of hours the

number of minutes of the delay. If he is obliged to procure a substitute, he must choose one accustomed to this kind of observation; but before entering his records he will carefully examine them. To distinguish the observations made by his substitute he will enter them in red ink.

As it is of the greatest importance that the series of observations should not be interrupted, and that there should be no omissions, each observer will do well to instruct beforehand one or more substitutes, who may be able upon occasion to take his place. If, in spite of these precautions, the observation has necessarily been omitted, its place will be left blank in the journal.

MONTHLY RECORD. (Form 122.)

In the monthly record the first page is devoted to observations of temperature, rainfall, clouds, and wind; the second to observations of the barometer, humidity, dew-points, rain-winds, and general summary, and to periodical or extraordinary phenomena. The headings of the columns indicate clearly the use of each.

For each instrument the columns follow each other in the order in which the observations are to be made, and, in the case of the barometer, one column is reserved to enter the observation *just as it is made*, and before any correction or reduction. As each sheet is to be regarded as an independent document, it should carry with it all that is necessary to correct the observations therein contained and to render them authentic. Thus the date of the year, the month, the precise locality, the latitude and longitude, the elevation of the instruments from the ground and above the sea, the nature and condition of the instruments which have been employed, and the amount of their corrections; finally, the signature of the observer. It will be sufficient for this to fill the blank spaces left after the different printed titles in the blank forms. The observer should not neglect this important duty.

Barometer.—The observed height of the barometer and the degree of the attached thermometer will be inscribed in the first two columns of the barometer record on the second page. This height will be reduced to freezing-point or 32° Fahrenheit by means of Table No. VII, and the whole correction of the instrument will be placed in the third column. The barometer, reduced to sea-level, will be placed in the fourth column.

Thermometer.—In the thermometrical observations the quantity above zero will be *always* written without a sign; the quantities below zero will be all *individually* marked with the sign *minus* (—) whether they follow each other or are isolated.

Wet-bulb.—On the second page, under the heading "Humidity and Dew-point," will be entered the indications of the dry and wet thermometers, after having applied to them the correction of the instruments, if there be any. By means of the psychrometrical tables will be found the dew-point and the degree of relative humidity, each of which has its column.

Under the heading "Winds," on page 1, the direction and force of wind will be indicated at each observation, using the letters N., NE., E., SE., S., SW., W., and NW., and, when practicable, the intermediate points. Indicate the *force* on a scale of 0 to 10 if the station is not supplied with an anemometer. This scale is printed on the form.

The character of clouds, both upper and lower, the amount and the direction from which they may be moving are inscribed in the proper columns at each observation.

Under the heading "Rain or Snow," on the first page, note carefully the time of beginning, time of ending, and total amount of rain or snow, and in the case of snow the average depth in inches. The amount of rain or snow should be measured at 2 p. m. preferably.

As to *casual phenomena*, although it is desirable, considering the small space the form of the table allows, to employ abbreviations to express the state of the sky and the different meteorological phenomena; nevertheless, observers should limit themselves to a small number, chosen from among the expressions which most frequently occur. If abbreviations are too much multiplied, they lose in clearness and certainty what they gain in conciseness. A meteorological journal should not resemble a page of algebra, where a badly formed letter or a misplaced sign renders the expression unintelligible.

For the additional observations the same rule should be followed.

Periodical and extraordinary phenomena will be inscribed, with their dates and the hour of their appearance.

Every change of position, or in the condition of the instruments, should be carefully entered, with the precise date at which it took place. By the side of the indication of the correction of the instrument will be placed, *correction applied* or *correction not applied*, according as the observations contained in the sheet shall have been corrected or not. The finished sheet *will be signed by the observer*.

The *reductions*, the *corrections*, and the *calculations of means*, should be made day by day and at the end of each month with the greatest punctuality. The daily mean temperature will be obtained by dividing the sum of the 7 a. m., 2 p. m., and *twice* the 9 p. m. observations by 4. The daily mean of the barometer, humidity, and dew point will be obtained by dividing the sum of the 7 a. m., 2 p. m., and 9 p. m. observations by 3. The necessary tables will be placed at hand, and each observation reduced, and the correction, if any, applied immediately. The summary of the month, and the rain wind data, on page 2, entered in the several columns, as explained on the blank, should be carefully inscribed.

The observer cannot be too thoroughly convinced that a meteorological journal which contains only rough observations, is only half made; in this condition it is wholly unfit to serve any scientific purpose. The observations cannot be compared rigorously with each other, nor with those of other stations.

These should be furnished in the annual meteorological summary (Form 128). This annual summary should also contain, when practicable, tables showing dates of occasional phenomena, observations of crops and flowers, trees and shrubs, &c., made out in the following forms:

The calculations desirable are as follows:

1. Each barometrical observation should be reduced immediately to the temperature of 32° Fahrenheit, by means of the tables, and the total correction of the barometer, if there is any, will be applied.

2. The daily means of the several instruments, resulting from the sum of the three observations made at these different hours, divided by three, except in the case of the thermometer, the mean of which are obtained by dividing the sum of the 7, 2, and *twice* the 9 o'clock observations by *four*, must be entered each day in the respective columns, after the observations of 9 p. m. It is needless to say that these means should be drawn solely from observations reduced and corrected.

3. The monthly means for each hour separately—that is, the monthly

mean of the observations of 7 a. m., and that of 2 p. m., and of the observations of 9 p. m.

4. The monthly means drawn from the means of each day; the monthly extremes of the instruments; the monthly amount of the rain, hail, or snow; the mean cloudiness of the sky; the prevailing wind, &c.

5. The annual means and amounts, and the respective extremes for the civil year.

It will be interesting to calculate, also, if the observer is so disposed, the mean of the seasons of the meteorological year, which begins December 1, to November 30, of the following civil year.

The meterological seasons are, then:

Winter—December, January, February.

Spring—March, April, May.

Summer—June, July, August.

Autumn—September, October, November.

Sample Forms for Special Reporting.

DATES OF OCCASIONAL PHENOMENA.

1881.	Frost.	Hoar frost only.	Snow.
January	1-13, 15, 31	2, 4-7, 9, 12, 16, 17, 20, 23, 26, 28	3, 11, 18
February	1-4, 8, 11, 12, 16-26, 28	11, 25	1, 2, 18-21, 23, 24
March	1, 3, 7, 8, 10, 12-14, 16, 17, 20-27, 29, 30	1, 8	14, 25-27
April	1, 4, 6, 10-13, 16-18, 21, 24, 25	2, 12, 13, 14, 18, 19, 22	12, 16
May	1-4, 6, 9	2-4, 10, 12, 15	1, 6, 7
June	4	5	
July			
August			
September	28, 29	29, 30	
October	14, 15, 17, 31	16, 18, 21, 26, 28	
November	1-3, 10, 12, 15, 21-30	2, 3, 14, 15, 24, 29, 30	20, 21, 22, 26
December	1-13, 16, 27, 29, 30	1-6, 8, 11-13, 19, 23, 27	1, 2, 5, 30

1881.	Hail.	Heavy rain.	Fog.	Lightning.	Thunder.	Lunar halo.	Solar halo.
January			13, 16				
February	2, 5, 17 (soft)		9-11, 16, 27, 28			1, 2	16
March			1, 7		30	8	
April	17	8					
May	1, 7, 10, 14		21, 27	20	14, 20		
June	3, 28	2[illegible], 24, 25		8, 9, 12 21, 29	3, 8, 9, 12, 21, 25, 29		
July		19, 29		8, 29	8, 9, 29		
August	17, 22, 31	22, 23, 25, 30, 31	2	13, 17, 21, 22, 30	13, 22, 23, 25, 30		
September	25	7, 9, 25	29	7	7	23	24
October	25		6-9, 23, 29				
November	11		7, 18				
December	30		8, 16, 18			22	

Observations of Crops and Flowers.

Grain, &c.								Green crops.				Flowers.	
Name.	When sown.		In flower.		In ear.		When cut.		Name.	When sown.	Above ground.	Stored.	Name.	In blossom.
Wheat	Nov.	11	June	22	July	10	Sept. 11		Potatoes	April	May 23	Oct. 23	Anemone	April 20
Oats	Mar.	29	June	20	July	11	Sept. 11		Turnips	do.	May 25	November (first week).	Wild hyacinth	May 24
Beans	Mar.	3	June	14			Aug. 15		Beet	do.	May 23	Nov. do.	Primrose	April 20
Peas	Mar.	1	June	9			July 23		Mangel	do.	May 23	Nov. do.	Ranunculus	April 20
									Onions	do.	May 2	Oct. 20	Wood violet	May 14
													Mayflower	May 23
													Jonquil	May 14
													Snowdrop	February 12
													Crocus	March 15
													Daffodil	April 18
													Forget-me-not	May 23
													Monkshood	July 16
													Sweet-william	July 15

Observations of Trees and Shrubs.

Forest trees, &c.						Fruit trees, &c.				Shrubs.			
Name.	In bud.		In leaf.		Divested of leaves.	Name.	In blossom.		Ripe.	Name.	In blossom.		Divested of leaves.
Field elm	May	16	May	24	Nov. 10	Apple	May	21	Sept. 19	Lilac	June	3	Oct. 30
Oak	May	21	June	2	Nov. 19	Pear	May	5	Aug. 25	Privet	Aug.	15	Nov. 5
Sycamore	April	20	May	5	Oct. 19	Cherry	April	28	Aug. 3	Syringa	May	18	Oct. 30
Plane	April	20	May	5	Oct. 21	Peach	April	20	None.	Laburnum	May	28	Oct. 28
Lime	April	16	May	8	Oct. 19	Red currant	April	20	Aug. 3	Red flowering currant	April	26	Nov. 23
Hawthorn	May	2	June	15	Nov. 5	White currant	April	25	Aug. 3				
Hazel	April	22	May	14	Nov. 2	Black currant	April	28	Aug. 8				
Ash	May	16	June	5	Nov. 5	Strawberry	May	26	July 20				
Beech	April	14	May	16	Oct. 25	Gooseberry	April	24	Aug. 30				
Horse chestnut	April	18	May	16	Nov. 3	Plum	May	5	Oct. 20				
						Apricot	April	7	None.				

In calculating all these different results, take, in order to be very exact, the means of the sums of all the observations during the period of time in question, by reason of the inequality of the length of the months.

The sums which form the basis of all these means should be inscribed in the tables in the place reserved for them.

The preceding calculations, after a little practice, will not appear difficult, and may be quickly performed, but it can hardly be too often urged upon the observer to make them without delay; otherwise, this task, which is slight if accomplished daily, would become very heavy if left to accumulate for several months. It is only by making the correction himself that the observer can institute his own comparisons, and really study the course of the meteorological phenomena. His interest will increase still more with the feeling that he is co-operating in a great work, which concerns at once his whole country and the science of the world, and the success of which depends upon the accuracy, fidelity, and devotion of all who take part in it.

A copy of the observations of each month should be forwarded during the first week of the following month, in order to be of service in the preparation of the Monthly Weather Review.

It should be carefully collated by two persons, one of whom reads the figures aloud. Each observer will receive for this purpose a double series of blank forms, one of which will be retained by him, and stamped envelopes for mailing a copy of the observations to this office at the close of each month. He will also regularly receive a copy of the Weather Review and the Annual Report of the Chief Signal Officer.

Many of the phenomena connected with the state of the atmosphere are of great interest for comparative climatology, especially from a practical point of view. The periodical phenomena of vegetation and of the animal kingdom, such as the epoch of the appearance and the fall of the leaves, of the flowering and ripening of the more generally cultivated fruits; the seed time and harvest of plants; the coming and going of migratory birds; the first cry of the frogs, the appearance of the first insects, &c.; the moment of the closing of rivers, lakes, and canals by ice, and of their opening; the temperature of springs at different periods of the year; the temperature in the sun compared to that observed in the shade; that of the surface, and that below the surface of the ground—all observations of this kind are valuable.

The observer will find it very instructive to project curves which indicate the diurnal, monthly, or annual variations of temperatures, of atmospheric pressure, of moisture, &c.

These graphic representations are of the greatest utility for the comparisons, speaking to the eye more clearly than simple figures.

EARTHQUAKES.

The Chief Signal Officer is desirous of collecting information in reference to all phenomena having a bearing on the physical geography of this continent; and it is requested that observers will furnish any information which they may possess, or be able to obtain, in regard to earthquakes occurring in their neighborhood.

It will be interesting to determine the geographical limits of the disturbance, and to ascertain whether it was confined to any particular geological formation. If the direction of the shock was observed at a few places, the centre of commotion could be determined; and if the time were accurately known at different points, the velocity of the earthwave could be calculated. Hence, an answer is requested to the following questions, viz:

1. Was the agitation felt by yourself, or by any other person in your vicinity?
2. What was the approximate time of the occurrence?
3. What was the number and duration of the shocks?
4. What was the direction of the motion?
5. What was the character of the disturbance; was it vertical, horizontal, or oblique; was it an actual oscillation; an upheaval and depression, or a mere tremor?
6. Was there any noise heard; and if so, what was its character?
7. Was the place of observation on soft ground, or on a hard foundation near the underlying rocks of the district?
8. Were any facts observed having apparently an immediate or remote bearing on this phenomenon?
9. What was the intensity of the force in reference to producing motion in bodies and cracks in walls?

NOTE.—Please reply to the *first* question, if to no other; for an answer to it is necessary, in order to determine the limits of the commotion.

The direction of the impulse may have been ascertained by observing the direction in which molasses, or any viscid liquid, was thrown up against the side of a bowl. The remains of the liquid on the side of a vessel would indicate the direction some time after the shock occurred.

GENERAL PHENOMENA OF CLIMATE.

Phenomena of a general character, of which the date of appearance cannot be mistaken, are very valuable. Series of years have in some cases been carefully observed, which would greatly add to the value of the current record, if forwarded with it. The following are of this class:

1. Breaking up of ice in large rivers or bays.
2. Date of greatest rise and lowest fall of water in large rivers, especially when periodic, as in parts of the interior.

3. General leafing and fall of leaf in deciduous forests. In most parts of the North and the interior, these are well marked and easily designated periods.

4. Beginning of growth and the end of growth or destruction of grasses in general; as on plains or prairies.

5. First growth, flowering, and maturity of important annual staples, with their period in days from the beginning to the end of vital action.

Voluntary observers are requested to include in their monthly reports all reliable information relative to the destruction of life and property coming to their knowledge, classifying it, as far as possible, as indicated in the following table:

Date of storms.	Nature of storms (tornado, northeast gale, &c.).	Section of country traversed by storm.	Number and names of persons killed.	Number and names of persons injured.	Number and names of vessels lost or damaged, with estimated amount of loss.	Number of houses, barns, and other buildings destroyed or damaged, with estimated amount of loss.	Estimated amount of damage to property.	Number of animals killed, and estimated value.

SPECIAL DIRECTIONS TO THE VOLUNTARY OBSERVERS OF THE SIGNAL SERVICE.

In the reduction of the meteorological records presented to this office, much additional labor has resulted from the occasional omission in the records of some important facts, and in a want of perfect uniformity in noting the phenomena. To insure uniformity in the records attention is called to the following remarks:

1. *Failure to record latitude and longitude, name and station of the observer, and date on each sheet;* the observer probably supposing it sufficient to insert them *once* on the first sheet sent, and so omitting them afterwards. This often renders it necessary to search back through all the series of registers to some one that contained them—perhaps in a former year. *They should be inserted on every sheet.*

2. *Designating the same place by different names,* thus rendering it impossible to distinguish whether it was one place or two, unless by accidentally noticing the similarity in the name of the observer or in the latitude and longitude. Such changes of name should be avoided when practicable, and when necessarily made, special attention should be called to it.

3. *Diversity in the mode of recording the barometer, as follows:*

(*a*) Integers record *in full,* thus 29.35. (THIS *is the proper mode.*)

(*b*) Integers omitted when the same as in the entry *next above,* thus 38.

(*c*) Integers omitted when the same as in the entry *next to the left.*

(*d*) Integers omitted when the same as in the entry next preceding in the order of time.

(*e*) Integers omitted, except where they are different from the usual ones at the place of observation.

(*f*) Integers inserted occasionally and apparently without any system whatever.

(*g*) A *constant* suppressed, and the excess or deficiency recorded, as + or —.

The proper mode is that indicated by (*a*).

4. *Diversity in the mode of recording the thermometer, when it is below zero,* as follows:

(*a*) Indicated by the sign minus — placed before it, thus —16°. (This *is the proper mode.*)

(*b*) Indicated by the same sign placed *after* it thus, 16°—.

(*c*) Indicated by writing it under a zero—thus $\frac{0}{16^\circ}$.

(*d*) Indicated by writing it after a zero, with a comma between, thus, 0,16°.

(*e*) Indicated by the *word* "below," or the abbreviation *b* written before or after it—thus 16° below, 16° b, b 16°, or below 16°.

The first (*a*) is the proper mode.

5. *Departure from the printed instructions in recording the degree of*

cloudiness, some observers reversing the figures and using **10** to denote a clear sky, and **0**, one entirely overcast; and others omitting the record altogether in the columns of cloudiness when the sky is clear, and in place of it sometimes inserting the word "*clear*" in the columns of "remarks," or elsewhere. Both lead to error, and should be avoided—the zero should always be inserted "in the narrow column," as directed, when the sky is clear.

6. *Diversity in the use of the character* (0) *in recording the motion of the clouds*, as follows:

(*a*) Used to signify a calm, or that there is no perceptible motion. (This *is the correct use.*)

(*b*) Used to signify that the sky is clear, instead of inserting it in the proper column.

(*c*) Used to signify that no observation was taken.

(*d*) Used to signify that the direction in which the upper current was moving could not be determined on account of the sky being either perfectly clear or entirely overcast.

The first (*a*) is the correct use.

7. *Want of full and proper records of the direction of the wind*, some observers recording the direction only after each change, and then omitting it so long as it continues the same, merely inserting a figure to denote the force. It is better to make the record in full. Other observers record the direction *towards* which the wind or clouds are moving instead of indicating that *from* which they come. A WIND *from* the North, or CLOUDS moving *from* the North, are to be denoted by N, and *from* the South by S, &c.

8. *Different kinds of thermometers or different exposures used for the dry and wet-bulb thermometers*, so that the observations are not comparable readily, if at all.

9. *Diversity in the use of the dash and the sign* (") as follows:

(*a*) To signify that the entry next above is to be repeated.

(*b*) To signify that the entry next to the left is to be repeated.

(*c*) To signify that the entry next preceding in the order of time is to be repeated.

(*d*) To signify nothing at all, but merely to fill a blank.

The use of these characters has caused much trouble in the reduction, and the true remedy would be to *avoid them altogether*, by making each record complete in itself.

10. *Illegibility of the records*, either from defective chirography or from being entered in pencil marks and partly erased.

FORM No. 122.

[To be filled up and sent on the first of each month, in an envelope addressed to "The Chief Signal Officer, U. S. Army, Washington, D. C."]

WAR DEPARTMENT, SIGNAL SERVICE U. S. ARMY, DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE AND AGRICULTURE.

Voluntary observer's meteorological record for the month of ——, 188 .

[Place of observation: ——, county of ——, State of ——; latitude ——; longitude ——; height of ground above the sea, —— feet; name and post-office address of observer ——.

Day of month.	Thermometer. Read at last observation of the day.		Rain and snow.				Clouds. 7 a. m.				Clouds. 2 p. m.				Clouds. 9 p. m.				Auroras.	Winds. 7 a. m.		Winds. 2 p. m.		Winds. 9 p. m.		Day of month.
							Upper clouds.		Lower clouds.		Upper clouds.		Lower clouds.		Upper clouds.		Lower clouds.									
	Maximum.	Minimum.	Time of beginning of rain or snow.	Time of ending of rain or snow.	Total amount of rain and melted snow, in inches.	Average depth of snow-fall, in inches.	Kind and amount.	Direction moving from.	Kind and amount.	Direction moving from.	Kind and amount.	Direction moving from.	Kind and amount.	Direction moving from.	Kind and amount.	Direction moving from.	Kind and amount.	Direction moving from.		Direction.	Force.	Direction.	Force.	Direction.	Force.	
1																										1
2																										2
3																										3
4																										4
5																										5
6																										6
7																										7
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30																										30
31																										31
Sums.																										Sums.
Means.																										Means.

The object of these observations is to enable the Chief Signal Officer, United States Army, to prepare a series of maps to illustrate the face of the sky, &c., over the United States for each day in the year, and thus to study the rise, progress, and course of American storms. Observers will be supplied with full directions for using all the instruments, on application to the Chief Signal Officer, Washington, D. C.

EXPLANATION OF THE ABOVE COLUMNS.

RAIN AND SNOW.

Under this head are entered the time of beginning and ending of the fall of rain or snow, and the true depth, in inches and hundredths, of the fall of rain or melted snow; also the depth of the snow. Rain to be indicated by R, and snow by S. When there is no rain or snow, mark 0. Amount of rain or melted snow should be recorded in inches, tenths, and hundredths, thus: 1.25, 6.03, 0.01, &c. If the measuring tube or stick gives figures 2, 5, or 10 times larger than the true depth, then these figures should be properly reduced before entering in the above columns.

CLOUDS.

Under this general head are entered three daily observations on the aspect of the sky, &c.: 1st. The "amount of cloudiness," designated by figures, 10 being entire cloudiness; 5 half cloudiness; 0 entire clearness; and intermediate numbers in proportion. 2d. The direction *from* which the clouds move, distinguishing between the upper and lower strata of clouds. This observation is important, as the course of the *clouds* is generally different from that of the *surface wind*, which is given in another column. 3d. The "velocity," or rate of motion, 10 being the highest, and 0 apparent rest. 4th. The description or "kind of clouds," to be entered by means of the following abbreviations: *S.*=Stratus; *Cu.*=Cumulus; *C.*=Cirrus; *N.*=Nimbus; *C. s.*=Cirro-stratus; *Cu. s.*=Cumulo-stratus; *C. cu.*=Cirro-cumulus.

AURORAS.

Auroras should be looked for every night, and if possible, several times. The detailed description should be given on the next page, but in this column should be entered the words *Aurora* when one is visible; *None* when clear enough to see that no aurora is present; *Obscured* when the sky is covered so as to hide aurora; *Blank* when no observation was made and nothing is positively known.

WINDS.

This is for the record of the direction *from* which the wind is blowing, and its force. The direction is to be entered in eight points of the compass: N., NE., E., SE., S.SW., W., NW., and if practicable, the intermediate half points. The force is to be estimated and registered by figures from 1 to 10, as in the first column of the following table. The figures in the last column, expressing the number of miles per hour, are *not to be used* in the register. A little practice will enable observers to make use of the figures in the first column, corresponding to light, gentle, fresh, strong, &c., with accuracy, and it is very important that such should be the case to make the record reliable. Observers having anemometers should, in addition to these estimates, also record the velocities given by the instrumental record; they should also add the total daily and monthly movement given by the anemometer dials.

0. Calm.							
1. Very light breeze,	varies between	1	and	2	miles	per	hour.
2. Gentle breeze,	" "	3	"	5	"	"	"
3. Fresh breeze,	" "	6	"	14	"	"	"
4. Strong wind,	" "	15	"	24	"	"	"
5. High wind,	" "	25	"	39	"	"	"
6. Gale,	" "	40	"	59	"	"	"
7. Strong gale,	" "	60	"	69	"	"	"
8. Violent gale,	" "	70	"	79	"	"	"
9. Hurricane,	" "	80	"	99	"	"	"
10. Most violent hurricane,	" from	100	upward.				

Date.	Barometer.													Humidity, dew point, &c.															
	7 a. m.				2 p. m.				9. p. m.					7 a. m.					2 p. m.					9 p. m.					
188–.	Observed reading.	Attached thermometer.	Correction and reduction.	Barometer corrected and reduced.	Observed reading.	Attached thermometer.	Correction and reduction.	Barometer corrected and reduced.	Observed reading.	Attached thermometer.	Correction and reduction.	Barometer corrected and reduced.	Daily mean, ¼ (7+2+9.)	Dry-bulb thermometer.	Wet-bulb thermometer.	Dew-point.	Tension of vapor.	Relative humidity.	Dry-bulb thermometer.	Wet-bulb thermometer.	Dew-point.	Tension of vapor.	Relative humidity.	Dry-bulb thermometer.	Wet-bulb thermometer.	Dew-point.	Tension of vapor.	Relative humidity.	*Daily mean of dry bulb.	Daily mean humidity.
1																														
2																														
3																														
4																														
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30																														
31																														
Sums.....																														
Means.....																														

Summary for ——, 188–.
Observer ——, County ——, Station ——, State ——.

Highest barometer during the month, ——
Lowest " " " " ——
Mean " " " " ——
Highest temperature " " " " ——
Lowest " " " " ——
Mean " " " " ——
Prevailing winds, ——
Maximum velocity or force, ——
Total number of miles traveled, ——
Total rainfall or melted snow, ——
No. of days on which 0.01 or more rain or snow fell, ——
No. of days on which cloudiness averaged 8 or more on a scale of ten, ——
Depth of snow, in inches, at close of month, ——
" snowfall, in inches, during month, ——
Thunder storms, dates of, ——
Hail, " ——
Frost, " ——
Aurora, " ——
Halos { Solar, " ——
Halos { Lunar, " ——
Meteors, " ——
Polar bands, " ——
Mirage, " ——
Winds, followed by rain, ——
" " " clear or fair weather, ——

Elevation of surface of mercury in cistern of barometer above sea-level, —— feet.
Instrumental error of barometer used, ——
Maker and No. of barometer used, ——
Kind of rain-gauge, ——
Maker and No. of thermometer—exposed, ——
" " " " maximum, ——
" " " " minimum, ——
" " " hygrometer, ——

Observers are specially requested to fill up this summary.

*The daily mean of dry-bulb thermometer is to be found by the formula ¼ (7 + 2 + 9 + 9). Fractions of degrees should be recorded by tenths, thus, 72°.1, &c.

Date. 188–.	Rain or snow.	Time of commencement.	Time of ending.	Wind direction preceding rain or snow.	Wind direction during rain or snow, at each observation.	Wind direction following rain or snow.	Rain and melted snow.		Wind direction at three observations preceding rain or snow.	Wind direction at three observations following rain or snow.
							Inches.	Hundredths.		

INSTRUCTIONS FOR FILLING UP.

1st column, record day of month and year.
2d " " whether rain or snow.
3d " " actual time of commencement (hour and date).
4th " " actual time of ending (hour and date).
5th " " direction of wind, observation immediately preceding time of commencement.
6th " " direction from which wind was blowing at each observation during continuance of precipitation.
7th " " direction of wind at observation immediately following time of ending.
8th " " total precipitation collected during storm.
9th " " direction from which wind was blowing at each of the three (3) observations immediately *preceding* the commencement of precipitation.
10th " " direction from which wind was blowing at each of the three (3) observations immediately *following* the ending of precipitation.

NOTE.—The wind directions recorded in columns Nos. 6, 9, and 10 must follow each other in the order in which the observations are taken.

CASUAL PHENOMENA.

Note observations of the following:

Thunder-storms: Time of occurrence and direction of motion. Distant thunder, without visible lightning. Tornadoes: Time of occurrence, width and direction of path, effects produced, and whether attended by electricity or hail. Lightning at a distance: Time of occurrence, direction from observer, whether zigzag, forked, or diffused. Objects struck by lightning, as trees, buildings, &c. Hail storms: Time of occurrence, direction and width of path, size and quantity of stones, and amount of injury. Aurora borealis: Time of appearance and disappearance, time of the visibility of arches, beams, and corona, their bearings and altitude in degrees, and whether there is a dark cloud below the arch. Zodiacal light: Time, intensity, extent, &c. Time of occurrence, apparent bearing, altitude in degrees, &c., of meteors, shooting stars, solar and lunar halos, parhelia, paraselenes, and mirage. Time of *early* and *late* frosts, particularly first and last. Depth of ground frozen, in feet and inches; disappearance of frost from the ground. Time of closing and opening of rivers, lakes, canals, and streams, and their extreme rise and fall. Temperature of the soil, and of wells and springs at least once each season. Earthquakes: Time of occurrence, direction of impulse, number of shocks, and effects produced. Hazy or smoky appearance of the atmosphere, smoke of forest fires: Time of occurrence and intensity. High winds, gales,

hurricanes, unusually heavy rains, or remarkable changes in the temperature between the regular hours of observation—date, time, and duration. Time of budding, leafing, blossoming, ripening, and fading of plants, trees, grasses, &c. Time of appearance, disappearance, migration, &c., of birds, insects, &c., character of sunset and sunrise, and other local signs of the weather of the coming day or season.

Annual summary of meteorological observations made by ——— ———, *at* ———, *for the year ending June* 30, 1879.

Months.	Mean pressure.	Temperature.			Mean relative humidity.	Total rain and melted snow.	
		Mean.	Max.	Min.			
1878.							
July							
August							
September							
October							
November							
December							
1879.							
January							
February							
March							
April							
May							
June							

N. B.—Columns for other data and miscellaneous notes may be added by the observer at his pleasure.

Certified to as a correct copy of the duplicate records in my possession.

——— ———, *Observer.*

ILLUSTRATION OF CLOUDS.

No. I

No. II.

CIRRUS (HOWARD). MORE THAN 6¼ MILES IN ALTITUDE.

Figs. 1 and 2, cats' tails; figs. 3 and 4, twisted tufts; fig. 5, plumage; fig. 6, horses' tails.

ILLUSTRATION OF CLOUDS.

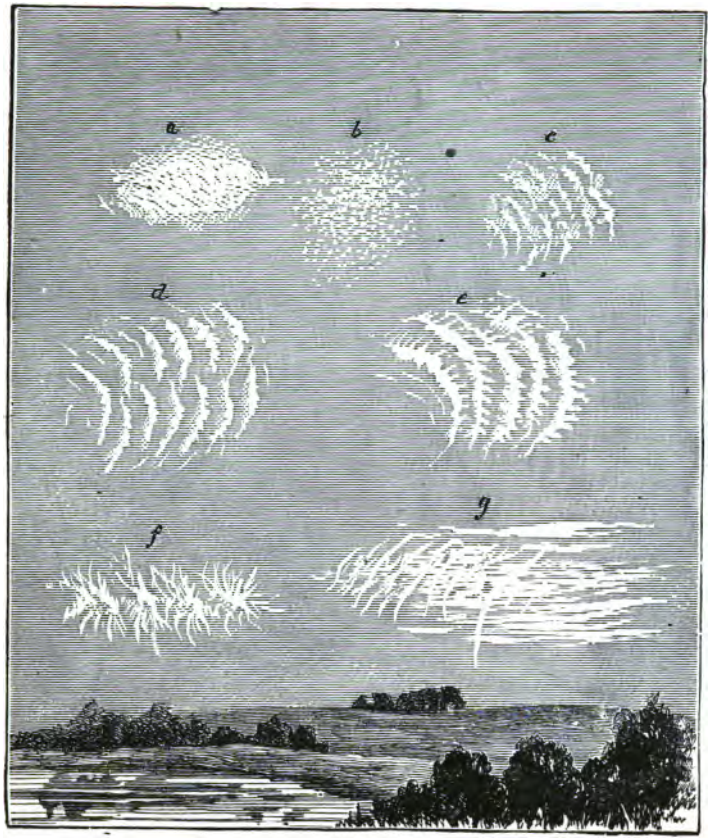
No. III.

No. IV.

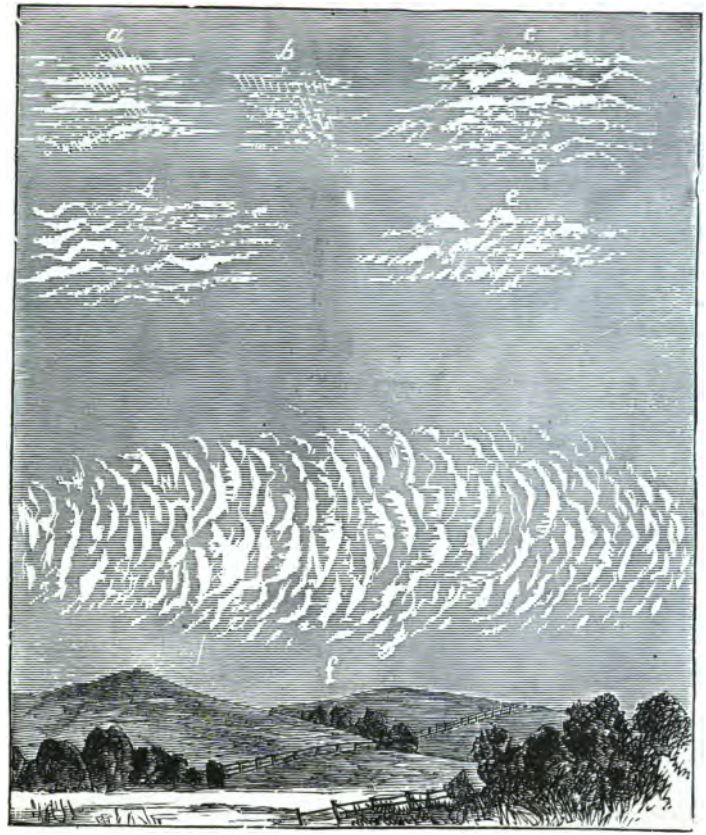
CIRRUS (HOWARD). MORE THAN 6¼ MILES IN ALTITUDE.

Fig. 7, fine pencils; fig. 8, longitudinated and palmated bands.

No. V.



No VI



CIRRO-STRATUS (HOWARD).

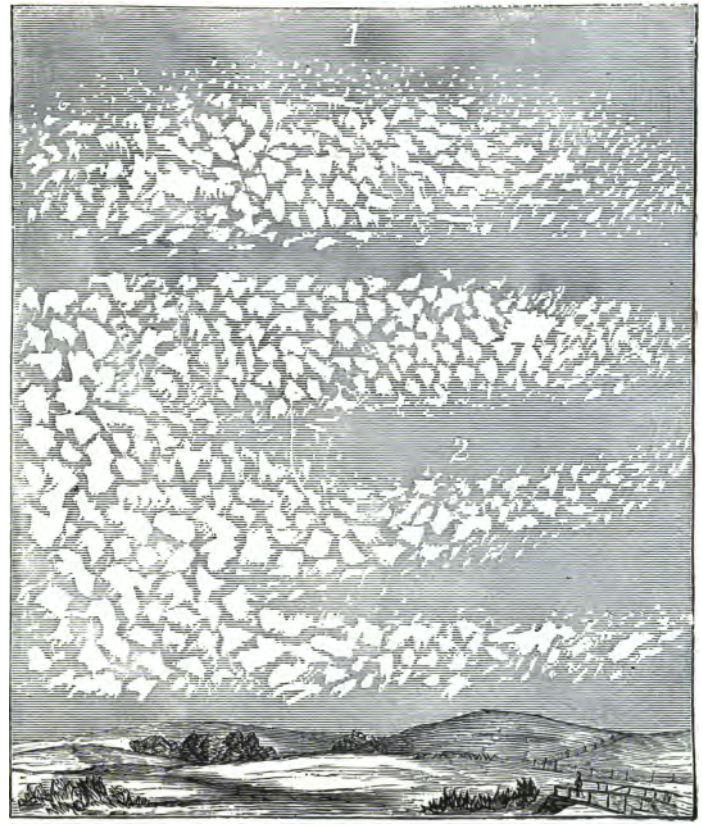
a, *b*, *c*, *d*, *e*, partial formation; *f*, perfect formation; *g*, nascent formation.

a, *b*, *c*, *d*, *e*, *f*, nascent formation.

ILLUSTRATION OF CLOUDS.

No. VII.

No. VIII.

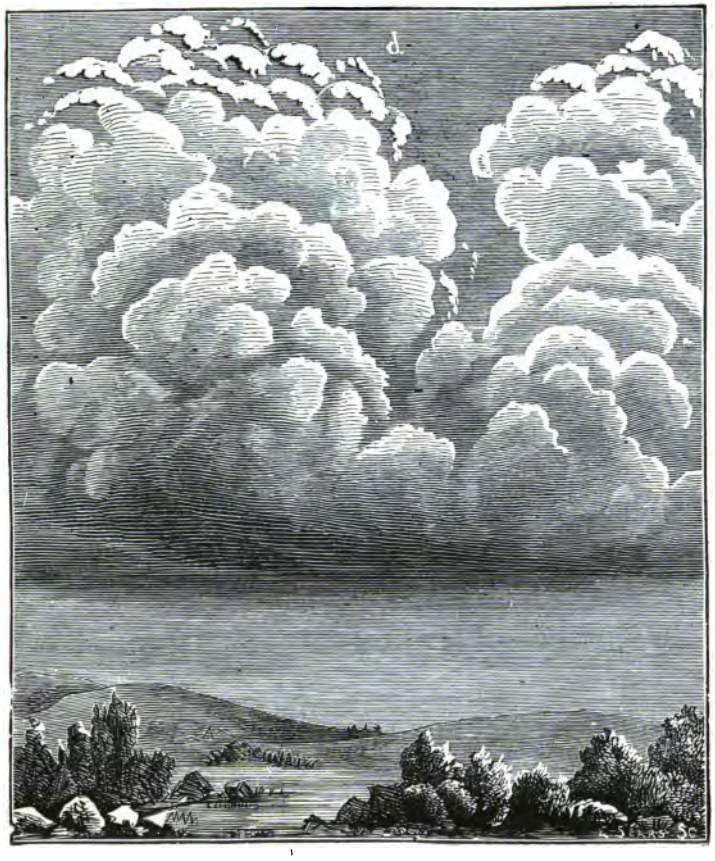


CIRRO-CUMULUS (HOWARD).

Fig. 1, perfect type; fig. 2, bizarre form; fig. 3, irregular form.

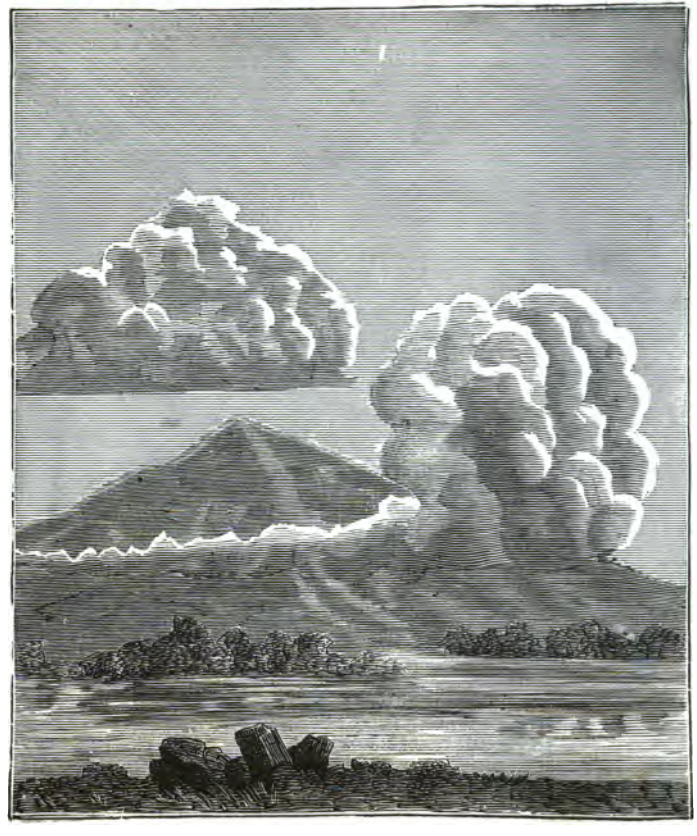
ILLUSTRATION OF CLOUDS.

No. IX.



CUMULUS *or* CUMULO-STRATUS (HOWARD).
PERFECT TYPE.

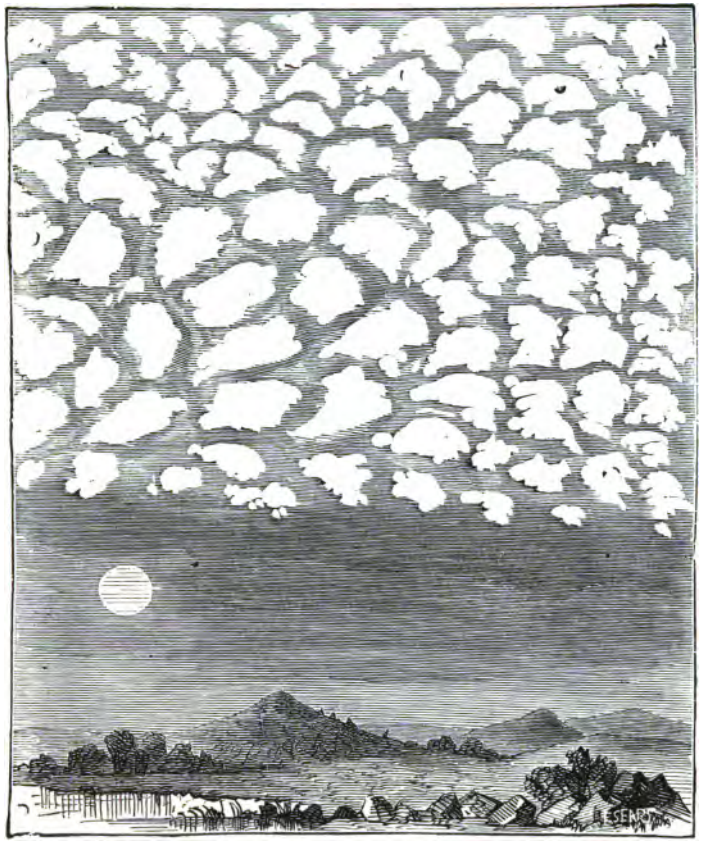
No. X.



CUMULUS *or* CUMULO-STRATUS (HOWARD).
NASCENT FORMATION.

ILLUSTRATION OF CLOUDS.

No. XI.



CIRRO CUMULUS (HOWARD).
PALLIO-CIRRUS (POEY).

No. XII.

NIMBUS (HOWARD).
PALLIO-CUMULUS (POEY).

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